全国本科院校机械类创新型应用人才培养规划教材

机械工程专业英语

余兴波
姜 波 编著
任 婷

课文的英文原文极具代表性
模块较多激发学生学习兴趣
配有阅读材料及其参考译文

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内 容 简 介

本书编写以机械工程专业英语基础知识够用为度，本着重在应用的原则，从机械工程专业基础知识出发，全书共20个单元，内容包括金属材料热处理、焊接工艺、金属切削机床与刀具、工程力学、机械原理与设计、CAD/CAM、模具结构及设计等。

本书可作为相关院校机械工程专业英语教材，也可供机械工程专业人士学习参考。

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前　　言

市场竞争日趋激烈的今天，民办高校、独立学院必须要走出一条属于自己的教育之路。引进职业化教育，创新实践教育体系，是保证民办高校、独立学院走出自己应用本科特色道路的有效措施。

为此，2010 年长春光华学院机械工程学院组织编写了一套《机械信息工程专业英语教程》。由机械工程学院副院长余兴波教授担任主编，分Ⅰ、Ⅱ两册，缓解了独立学院机械工程、信息工程专业学生专业英语教材短缺的局面。该教材自出版使用以来，收到了较好的教学效果。

由于教学需求，按学院领导关于教材建设的要求和安排，在北京大学出版社的支持和鼓励下，现对该套教材进行修订、补充和改编，按《机械工程专业英语》和《电气信息工程专业英语》两套教材出版，修订者认真研究了一些学校的师生在使用该教材过程中提出的宝贵意见，并对编写中存在的错误进行逐一修订。修订内容分为“正文”、“阅读课文”的专业译文，注释，word-study，sentence patterns 和 exercises 等。《机械工程专业英语》全书由 20 篇课文组成，《信息工程专业英语》全书由 12 篇课文组成，每套教材课文“正文”和“阅读课文”，均附有参考译文。修订再版的教材，其书稿的文责由修订者负责。

本书由余兴波、姜波、任婷编著。

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全书的统稿、校稿工作由余兴波、任婷、顾晓琳完成。

本书编写过程中得到学院董事长、院长等各位领导的大力支持和帮助；学院公共外语教研部主任滕玉梅教授审阅了书稿；北京大学出版社编辑们在教材方面做了大量工作。在

此，一并表示感谢。

由于编写水平有限，时间紧迫，有些是属专业英语课程实践教学体系改革方面所做的点滴尝试，其中定会存在不当和疏漏之处，敬请读者批评指正。

编　者

2013 年 7 月　于长春

目　　录

Unit 1

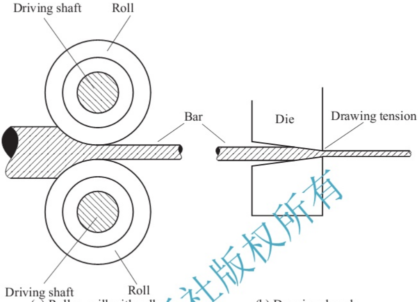
Text 1: Heat Treatment of Steel

We can alter the characteristics of steel in various ways. In the first place, steel which contains very little carbon will be milder than steel which contains a higher percentage of carbon, up to the limit of about 1.5%[3]. Secondly, we can heat the steel above a certain critical temperature, and then allow it to cool at different rates. At this critical temperature, changes begin to take place in the molecular structure of the metal. In the process known as annealing, we heat the steel above the critical temperature and permit it to cool very slowly. This causes the metal to become softer than before, and much easier to machine. Annealing has a second advantage. It helps to relieve any internal stresses which exist in the metal. These stresses are liable to occur through hammering or working the metal, or through rapid cooling. Metal which we cause to cool rapidly contracts more rapidly on the outside than on the inside. This produces unequal contractions, which may distortion or cracking. Metal which cools slowly is less liable to have these internal stresses than metal which cools quickly.

On the other hand, we can make steel harder by rapid cooling. We heat it up beyond the critical temperature, and then quench it in water or some other liquid. The rapid temperature drop fixes the structural change in the steel which occurred at the critical temperature, and makes it very hard. But a bar of this hardened steel is more liable to fracture than normal steel. We therefore heat it again to a temperature below the critical temperature, and cool it slowly. This treatment is called tempering. It helps to relieve the internal stresses, and makes the steel less brittle than before. The properties of tempered steel enable us to use it in the manufacture of tools which need a fairly hard steel. High carbon steel is harder than tempered steel, but it is much more difficult to work.

These heat treatments take place during the various shaping operations. We can obtain bars and sheets of steel by rolling the metal through huge rolls in a rolling-mill (Fig. 1.1(a)). The

roll pressures must be much greater for cold rolling than for hot rolling, but cold rolling enables the operators to produce rolls of great accuracy and uniformity, and with a better surface finish[4]. Other shaping operations include drawing into wire (Fig. 1.1(b)), casting in moulds, and forging.



(a) Roller-mill with rolls　　(b) Drawing-bench

Fig. 1.1　Shaping operations

Words and Expressions

1. mild　[maild]　*a.* ① 温(和、暖)的，柔(软)的，适度的
   ② 低碳的
2. critical　['kritikəl]　*a.* ① 临界的，极限的，转折(点)的
   ② 批评的
   ③ 决定(关键)性的

   critical temperature　*n.* 临界(值)
   临界温度
3. molecular　[məu'lekjulə]　*a.* 分子的，分子组成的
4. annealing　[ə'ni:liŋ]　*n.* (低温)退火，煅烧，韧化，热处理
5. cause M to+inf.　使 M(做)
6. relieve　[ri'li:v]　*v.* ① 减压、卸载
   ② 释放、替(调)换
7. liable　['laiəbl]　*a.* ① 易于... 的，有... 倾向的
   ② 应服从的

   (be) liable to　... 易发生的，有... 倾向的

8. give rise to　　... 引起，产生，导致，得出

9. distortion　[dis'tɔːʃən]　　*n.* 变形(态，率)，挠曲

10. cracking　['krækiŋ]　　*n.* ① 破(爆)裂，裂缝(开)
② 噪声，噼啪声
a. 分裂(解)的，极大的，猛烈的
ad. 分裂(解)地，极大地

11. quench　[kwentʃ]　　*v.* ① (使)熄灭，急冷，冷却，熄弧
② 把... 淬火(硬)，硬化
n. 抑制，阻尼，减震

12. fracture　['fræktʃə]　　*v.* (使)破裂(碎)，(使)断裂
n. ① 断口(面)，裂缝(痕，面)
② 折断

13. brittle　['britl]　　*a.* 脆(性)的，易碎的，易损坏的

14. temper　['tempə]　　*v.* ①回火 ②调节(和、匀)
n. 性情、脾气

15. roll　[rəul]　　*v.* 滚轧(压)，辗压(平)，轧制(平)
n. ①滚动 ②轧制 ③轧辊

16. uniformity　[juːni'fɔːmiti]　　*n.* ① 均匀(性)
② 一致(性)，统一，单调
③ 同类(样)
④ 卷筒(轴)，绕线轴

17. drawing　['drɔːiŋ]　　*n.* ①拉、拔、抽、拉
② 绘(制)图，图样(纸、表)

18. casting　['kaːstiŋ]　　*n.* ①铸造(法)，铸塑，浇铸，铸件
②投(掷)，抛

19. forging　['fɔːdʒiŋ]　　*n.* 锻造法，锻件
a. 锻造(的)

20. drawing bench　　拉拔机，拉丝机，拉床

21. die　[dai]　　*v.* 冲切，用模(压)成形，模制
n. (pl. dies)模具，冲模(锤)

Notes

1. 本篇课文涉及机械工程热加工中金属材料热处理方面的基础知识，课文题目：钢的热处理。

2. 本篇课文语法现象的重点：表示比较关系的状语从句。通常是由 than 或 as 引出，里面常有一些成分没有体现出来，从句多数省略。

3. In the first place, steel which contains very little carbon will be milder than steel which contains a higher percentage of carbon, up to the limit of about 1.5%. 该句是由“than”引导的比较状语从句，前后比较的两个“steel”，其后面都有一个由“which”引导的限制性定语从句。整个句子可译为：第一，含碳量很低的钢比含碳量较高的钢(含碳量的极限范围大约是 1.5%)会更软。

4. The roll pressures must be much greater for cold rolling than for hot rolling, but cold rolling enables the operators to produce rolls of great accuracy and uniformity, and with a better surface finish. 该句是复合句，两个分句由“but”连接，第一个分句是由“than”引导的比较状语从句构成，比较的两个事物由介词短语“for cold rolling”和“for hot rolling”给出。全句可译为：冷轧和热轧相比较，冷轧滚压力肯定大得多，而且冷轧工艺使操作者能生产出高精度、均匀性好和表面粗糙度较好的轧制卷钢。

Word-Study

Ⅰ. *Likely, Liable, Susceptible, Probobly, Risk/Danger*

1. The work 2. The new engine 3. An explosion	is likely to	start early next. be a good one. occur at any minute.
4. The new engine 5. An explosion 6. The metal 7. The work	will probably	occur at any minute. be very expensive. become overheated. be delayed until next year.
8. There is a risk/danger		of an explosion(occurring). that an explosion will occur. of the engine becoming overheated. that the engine may become overheated.
9. This road 10. The region	is liable to is susceptible to	frost damage. (*n.*) earthquakes.

Ⅱ. *Bring about, Produce, Cause, Give rise to*

1. Changes in temperature 2. The high temperature 3. These experiments 4. A drop in pressure	may will can	bring about produce give rise to	changes in the length of the bar. cracks in the furnace walls. new methods of construction. cylinder condensation.
5. Automation		cause	a lot of unemployment.

Ⅲ. *Expand, Contract*

Most substances expand when they are heated. =They grow bigger or longer.
Most substances contract when they are cooled. =They grow smaller or shorter.

When substances are heated, expansion takes place.
When substances are cooled, contraction takes place.

The coefficient of expansion, which tells us how much a substance will expand for each degree rise in temperature, is different for different substances.

Ⅳ. *Help, Assist, Facilitate*

1. Annealing helps to remove(helps or assists in removing)internal stresses from the metal.
2. Safety devices help to prevent (help or assist in preventing) accidents in the machine shop.

3. A good transport system	facilitates	the distribution of goods.
4. Prefabrication of the walls		rapid erection of houses.
5. The use of standard components		replacement when they are worn.

Sentence Patterns

Ⅰ. *Enable, Allow, Make, Permit, Cause+Infinitive*

Note: Enable really means to make possible, but it is often used in the same sense as allow and permit. Let is spoken, but not often written in this sense. With let and make, the word 'to' is not used before the infinitive.

1. The microscope	enables	scientists	to	examine very small objects.
2. A thermometer		the doctor		measure body temperature.
3. Expansion joints	permit	the pipes	to	expand or contract.
4. Safety valves	allow	the steam		escape from the boiler.
5. We		the metal		cool slowly.
6. The heat	caused	the metal	to	melt
7. Weakness in the metal		it		fracture under tension.
8. The heat	made	the metal melt.		
9. Weakness in the metal		it fracture under tension.		

Ⅱ. *Comparative*

Here are some of the most useful patterns for comparing two things:

Steel	is	stronger far stronger slightly stronger more expensive much more expensive a much more expensive material a much more expensive material to produce	than	cast - iron
Cast - iron	is	weaker less expensive much less expensive a much less expensive material a much less expensive material to produce	than	steel.
Cast - iron	is	not so expensive not quite so expensive not quite such an expensive material not quite such an expensive material to produce	as	steel.
Cast - iron	is	as useful almost as useful almost as useful a material	as	steel.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is the limit of the higher percentage of carbon in the steel?
2. What is the second advantage of annealing?
3. What is tempering? And what is the function of tempering?
4. How can we obtain bars and sheets of steel?
5. How can we make steel harder?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) distortion	A) 临界温度
2. ( ) critical temperature	B) 分子的
3. ( ) molecular	C) 冲切
4. ( ) annealing	D) 拉拔机
5. ( ) forging	E) 退火

6. ( ) drawing bench　　　　F) 变形
7. ( ) die　　　　　　　　　G) 锻造法

Ⅲ. Join the two statements in each line, by comparing one with the other. Turn the comparison round both ways:

e. g. A is larger than B.
B is not so large as A, etc.

1. The carbon content of mild steel is 0.2%; the carbon content of cast - steel is 1.2%.
2. Wrought - iron contains 0.02% of carbon; it contains 0.02% of manganese.
3. The British engine weighs 3 tons; the French engine weighs 3.5 tons.
4. The electric heater costs a penny an hour to run; the gas heater costs two pence an hour.
5. Cast iron contains up to 3.0% of silicon; it contains up to 1.5% of phosphorus.
6. The temperature in this room is 28℃; the temperature outside the rood is 22℃.

Ⅳ. Complete these statements using the verbs *enable*, *allow* or *make*.

1. The rise in temperature ________ the mercury ________ rise up the tube.
2. The motorway ________ motorists ________ travel from London to Birmingham much more quickly than before.
3. The use of tractor ________ more food ________ be produced more cheaply.
4. The presence of oxygen ________ the mixture ________ burn rapidly.
5. The failure of both engines ________ the aircraft ________ crash.
6. The increase in exports ________ the country ________ import more raw materials.
7. The risk of an explosion ________ the workers ________ leave the factory.
8. The speed of the train ________ it ________ leave the rail on the curve.
9. The fluidity of cast-iron ________ it ________ be cast into intricate shapes.
10. The use of a pressure gauge ________ the engineer ________ read the boiler pressure.

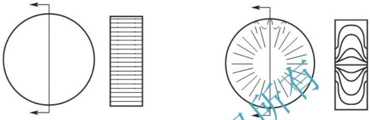
Reading 1: Metal Forming Processes

Mechanical working processes are used to achieve optimum mechanical properties in the metal. Metal working reduces any internal voids or cavities present and thus makes the metal dense. The impurities present in the metal also get elongated with the grains and in the process get broken and dispersed throughout the metal. This decreases the harmful effect of the impurities and improve the mechanical strength.

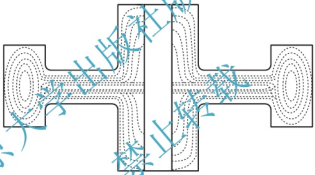
Nature of Plastic Deformation

Plastic deformation is the deformation which is permanent and beyond the elastic range of the material. Often, metals are worked by plastic deformation because of the beneficial effect that is imparted to the mechanical properties by it. The necessary deformation in a metal can be achieved by application of large amount of mechanical force only or by heating the metal and then applying a small force.

The deformation of metals which is caused by the displacement of the atoms is achieved by one or both of the processes called slip and twinning. The details of the microscopic deformation methods can be found in the textbooks of metallurgy. On the macroscopic scale, when plastic deformation occurs, the metal appears to flow in the solid state along specific directions which are dependent on the type of processing and the direction of applied force. The crystals or grains of the metal get elongated in the direction of the metal flow. This flow of metal can be seen under microscope after polishing and suitable etching of the metal surface. These visible lines are called 'fibre flow lines', some representative specimens of which are presented in Fig. 1. 2.



(a) Direction of grain flow in a gear blank



(b) Direction of grain flow in a flgwheel

Fig. 1. 2 Fibre flow lines (Courtesy B. W. Niebel and A. B. Draper: Product Design and process Engineering, McGraw - Hill, New York)

Since the grains are elongated in the direction of flow, they would be able to offer more resistance to stresses acting across them. As a result, the mechanically worked metals called wrought products would be able to achieve better mechanical strength in specific orientation, that of the flow direction. Since it is possible to control these flow lines in any specific direction by careful manipulation of the applied forces as shown in Fig. 1. 2, it is possible to achieve optimum mechanical properties. The metal, of course, would be weak along the flow lines.

The wastage of material in metal working processes is either negligible or very small, and the production rate is in general very high. These two factors give rise to the economy in production.

Hot Working and Cold Working

The metal working processes are traditionally divided into hot working and cold working processes. The division is on the basis of the amount of heating applied to the metal before applying the mechanical force.

Those processes, working above the recrystallisation temperature, are termed as hot working processes whereas those below are termed as cold working processes.

Under the action of heat and the force, when the atoms reach a certain higher energy level, the new crystals start forming which is termed as recrystallisation. Recrystallisation destroys the old grain structure deformed by the mechanical working, and entirely new crystals which are strain free are formed. The grains in fact start nucleating at the points of severest deformation. Recrystallisation temperature as defined by American Society of Metals is "the approximate minimum temperature at which complete recrystallisation of a cold worked metal occurs within a specified time."

The recrystallisation temperature is generally between one-third to half the melting point of the most of the metals. Typical values of recrystallisation temperature are given in Table 1.1. The recrystallisation temperature also depends on the amount of cold work a material has already received. Higher the cold work, lower would be the recrystallisation temperature as shown in Fig. 1.3.

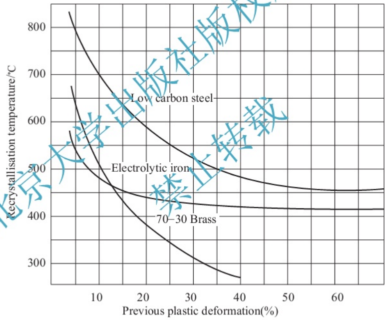


Fig. 1.3 Effect of amount of plastic deformation on the recrystallisation temperature

Table 1.1 Minimum recrystallisation temperatures

Material	Recrystallisation Temperature/℃	Material	Recrystallisation Temperature/℃
Lead	Below room temperature	Iron	450
Tin	Below room temperature	Nickel	600
Cadmium	Room temperature	Titanium	650
Zinc	Room temperature	Beryllium	700
Magnesium	150	Molybdenum	900
Aluminium	150	Tantalum	1000
Copper	200	Tungsten	1200

Though cold work affects the recrystallisation temperature to a great extent, there are other variables which also affect.

In hot working, the process may be carried above the recrystallisation temperature with or without actual heating. For example, for lead and tin the recrystallisation temperature is below the room temperature and hence working of these metals at room temperature is always hot working. Similarly for steels, the recrystallisation temperature is of the order of 1000℃, and therefore working below that temperature is still cold working only.

参考译文：

Reading 1　金属成形工艺

机械加工通常被用作获取最佳金属力学性能的工艺方法。金属加工可减少金属内部存在的缝隙或孔洞，因此能够使金属密实。在加工过程中，金属中存在的杂质也会使金属颗粒拉长而破裂，并分散在整个金属中，这样会减少杂质对金属的有害影响并且改善其机械强度。

塑性变形的本质

塑性变形指的是永久性的并且超出了材料弹性范围的变形。由于塑性变形有利的效应会带给金属材料良好的机械性能，所以金属常常被加工而产生塑性变形。金属内这种必要的变形可以运用大的机械力来实现，或者通过加热金属，然后施加小的作用力获取。

由原子错位引起的金属变形可以通过一个或两个称之为滑移和孪晶作用的过程得到。这种微观变形方法的详细资料可以在冶金学教科书中看到。在宏观情况下，当塑性变形发生时，根据加工过程的类型和作用力的方向而呈现金属沿某确定的方向的固态流动，金属的晶体或者颗粒在金属流动的方向上被拉长。金属表面进行抛光和适当的腐蚀后，在显微镜下可以看到金属的这种流动，这些可见的流动线被称为“纤维流线”，在图 1.2 中列举了流线某些有代表性的试样。

由于金属颗粒在流动的方向被拉长，所以对作用在其横截面的应力能够产生更多的阻力。因此，机械加工过的金属称之为“可锻产品”，在确定的方位，即流动方向上，它能够获得较好的机械强度。如图 1.2 所示，通过仔细操纵施加力，可能控制任何具体方向的(变形)流线，因此可能获得最佳机械性能。当然，金属将会沿着变形流线方向而变弱。

在加工过程中损耗的原料非常小或是可以忽略，总的来说生产率是非常高的，这两个因素决定生产上的经济性。

热加工和冷加工

金属的加工工艺，传统上分为热加工和冷加工过程。这种划分是以施加机械力之前，施加给金属的加热量多少为基础的。

加工过程中，在再结晶温度之上而进行的这些加工过程叫做热加工过程，在此温度之下而进行的加工过程叫做冷加工过程。

在热量和外力的作用下，当原子微粒达到某一较高能量水平时，新的晶体开始形成，这称为再结晶。再结晶破坏因机械加工而变形了的老晶粒结构，从而形成全然无变形的新

晶体形态。实际上这些颗粒开始在最严重形变点上成核。再结晶温度被美国金属学会定义为“近似最低温度”，在这温度之下，冷加工金属的完全再结晶出现在特定的时间内。

一般情况下，再结晶温度是处在大多数金属熔点的三分之一到二分之一之间。再结晶温度的典型值在表 1.1 中给出。再结晶温度也根据原材料正接收的冷加工量来决定，冷加工温度越高，再结晶温度就会越低，如图 1.3 所示。

虽然冷加工在很大程度上影响再结晶的温度，但是也有其他可变因素对其有影响。在热加工中，无论是否有实际加热，该过程都可以传至再结晶温度之上。举个例子，铅和锡的再结晶温度低于室温，因此，这些金属在室温下进行的加工总是热加工。同样的，对于钢来说，再结晶温度具有 1000℃，因此在低于这个温度下进行的加工仍然只是冷加工。

Unit 2

Text 2: Welding

There are a number of methods of joining metal articles together, depending on the type of metal and the strength of the joint which is required[3]. Soldering gives a satisfactory joint for light articles of steel, copper or brass, but the strength of a soldered joint is rather less than a joint which is brazed, riveted or welded. These methods of joining metal are normally adopted for strong permanent joints.

The simplest method of welding two pieces of metal together is known as pressure welding. The ends of metal are heated to a white heat——for iron, the welding temperature should be about 1300℃——in a flame. At this temperature the metal becomes plastic. The ends are then pressed or hammered together, and the joint is smoothed off. Care must be taken to ensure that the surfaces are thoroughly clean first, for dirt will weaken the weld. Moreover, the heating of iron or steel to a high temperature causes oxidation, and a film of oxide is formed on the heated surfaces. For this reason, a flux is applied to the heated metal. At welding heat, the flux melts, and the oxide particles are dissolved in it together with any other impurities which may be present. The metal surfaces are pressed together, and the flux is squeezed out from the centre of the weld. A number of different types of weld may be used, but for fairly thick bars of metal, a vee-shaped weld should normally be employed. It is rather stronger than the ordinary butt weld.

The heat for fusion welding is generated in several ways, depending on the sort of metal which is being welded and on its shape[4]. An extremely hot flame can be produced from an oxy-acetylene torch. For certain welds an electric arc is used. In this method, an electric current is passed across two electrodes, and the metal surfaces are placed between them. The electrodes are sometimes made of carbon, but more frequently they are metallic. The work itself constitutes one of them and the other is an insulated filler rod. An arc is struck between the two, and the heat which is generated melts the metal at the weld. A different method is usually employed for welding sheets or plates of metal together. This is

known as spot welding. Two sheets or plates are placed together with a slight overlap, and a current is passed between the electrodes. At welding temperature, a strong pressure is applied to the metal sheets. The oxide film, and any impurities which are trapped between the sheets, are squeezed out, and the weld is made[5].

Words and Expressions

1. joint	[dʒɔint]	*v.* 接(结)合，连(焊)接，搭接
		n. 接合点(处、面)，接(焊)缝
		a. 连接的，共同(有)的
2. solder	['sɔldə]	*n.*(低温)焊料(剂、锡、药)
		v. (低温)焊，软(锡、银、钎)焊接
soldering		*n.* 低温焊接，软钎焊接
3. copper	['kɔpə]	*n.* 紫(红)铜
4. brass	[brɑːs]	*n.* 黄铜
5. braze	[breiz]	*v.* (锌铜合金)钎接，铜(钎、硬)焊
		n. (锌铜合金)钎接，铜(钎、硬)焊
braze welding		钎接焊
6. rivet	['rivit]	*n.* 铆钉
		v. ① 用(铆钉)铆接(合、紧)，固定(结)
		② 敲打……使成铆钉头(以铆紧)
		③ 集中(注意)，(on/upon)吸引
7. weld	[weld]	*n.* ①焊接，熔焊(接)；②焊缝，焊接点，焊接接头
		v. 焊接，熔焊(接)(on/upon)
8. rather less than		比…还小(低)一些；比…多少有些小(低)
9. (be)known as		称为，通称，叫做
10. plastic	['plæstik]	*a.* 可塑的，塑性的
		n. (常用 pl)塑料(胶)，合成树脂
11. smooth	[smuːð]	*a.* 平整的
smooth off		…修平，磨光
12. weaken	['wiːkən]	*vt.* 削弱，减弱
		vi. 变弱
13. oxidation	[ɔksi'deiʃən]	*n.* 氧化(作用、层)
14. oxide	['ɔksaid]	*n.* 氧化物
		a. 氧化物(皮、层)(的)
15. flux	[flʌks]	*n.* ① 焊剂(药)，钎剂
		② 造渣、渣化、矿渣
16. dissolve	[di'zɔlv]	*v.* (使)溶(分、瓦)解，溶(融、液)化
		n. 溶解，溶化
17. impurity	[im'pjuəriti]	*n.* 杂质，夹杂物

18. squeeze [skwiːz] *v.* 挤(压、干)，压榨
n. 压榨，挤压，夹

19. depend on
① 依靠、依赖
② 信赖、信任
③ 视 ... 而定，取决于

20. oxy－acetylene [ˈɔksi－əˈsetiliːn] *a.* 氧化乙炔的
oxy－acetylene torch 氧(乙)炔焊炬
oxy－acetylene welding 氧(乙)炔焊接，气焊

21. electrode [iˈlektrəʊd] *n.* (电、焊)极，(电)焊条

22. metallic [miˈtælik] *a.* (含、似)金属的，金属(性、质、制)的

23. filler [ˈfilə] *n.* 填充物(剂)，填(充、缝)料，垫片

24. overlap [ˈəuvəˈlæp] *v.* & *n.* 重叠，交叠，搭接(部分)，互搭

25. trap [træp] *n.* 陷阱，夹子，放气阀，活门
v. 把 ... 夹(关、封闭、密封)在里面

Notes

1. 本篇课文涉及机械工程热加工中焊接的基础内容，题目是：焊接。

2. 本篇课文语法现象的重点：被动语态。

3. There are a number of methods of joining metal articles together, depending on the type of metal and the strength of the joint which is required.

句中 depending on... 是现在分词短语作状语，表示条件；which 引导的限制性定语从句中，which 是关系代词，修饰前面的 the strength of the joint。整个句子可译成：根据金属的种类和焊接接头强度的不同，有许多将金属物件连接在一起的方法。

4. The heat for fusion welding is generated in several ways, depending on the sort of metal which is being welded and on its shape.

句中 depending on... and on... 是两个现在分词短语作条件状语，其中，省略了一个 depending，定语从句 which is being welded，是进行时的被动语态，修饰前面的 the sort of metal，主句是一般现在时的被动语态，分词 for... 引导的介绍短语作 the heat 的定语，全句可译成：视焊接金属的种类及其形状不同，焊(接)热可由几种方式产生。

5. The oxide film, and any impurities which are trapped between the sheets, are squeezed out, and the weld is made.

该句是由并列连词 and 连接的并列主从复合句。“and”前面的分句是一主从复合句，其两个并列部分，the oxide film, and any impurities 共同构成主语，其中，any impurities 由关系代词 which 引导的定语从句所修饰限制，主从复合句的谓语是由一般现在时的被动语态组成，即 are squeezed out。因此，全句可译成：氧化膜和夹封在金属板之间的任何杂质都被挤压出来，随之形成了一个焊缝。

Word-Study

Ⅰ. *Exploit, Utilize, Employ, Use, Make use of*

1. The government intends to
2. It will be difficult to
3. This country failed to

} exploit / make use of {

- the natural resources of the country.
- this invention commercially.
- its five-year lead over other countries in jet-engines.

4. The properties of uranium are
5. Electrical power from the generator is
6. Steam at boiler pressure is
7. Different types of electric arc are

} used / utilized / employed {

- in nuclear reactors
- in the motor
- to produce draughts of air
- in the boiler.
- for various purposes.

Ⅱ. *Fairly, Rather, Slightly*

1. The temperature in the boiler is {
   - normal(500℃).
   - slightly high(505℃).
   - fairly high(=This is an advantage).
   - rather high(=This is a disadvantage).

2. (Comparative)
   The temperature in the boiler is {
   - slightly above normal(505℃)
   - rather above normal (520℃)
   - slightly higher than it should be.
   - rather higher than it should be.

Note: rather, not fairly, is used with comparatives, whether they indicate an advantage or a disadvantage.

Sentence Patterns

Ⅰ. *The Impersonal Passive*

In the first four sections, we avoided using the passive of statement, and concentrated on the types of statement which are frequently made in the active form, but you must remember that the majority of statements in technical writing are in the passive form, because the technical writer wants to be objective and impersonal. He does not use the passive form very often.

Here are a few examples of the change from active into passive.

Active	Passive
The driver starts the engine. He welds the plates together.	The engine is started. The plates are welded together.

（续）

Active	Passive
The furnace smelts the ore. The man sharpened his tool. He welded the plates together.	The ore is smelted in the furnace. His tool was sharpened. The plates were welded together.
They will start the work soon. We must lubricate bearings. A lathe can cut screws.	The work will soon be started. Bearings must be lubricated. Screws can be cut on a lathe.

As you see, passive constructions require this pattern:

(PRO)NOUN+a form of be+PAST PARTICIPLE

Ⅱ. *Should*

This word is used very often in technical writing, with several slightly different meanings.

1. Instructions to operators, employees, etc.

   These machines should be handled with great care.

   Safety precautions should be observed at all times.

   The results of the experiment should be plotted on a graph.

   N. B. this is sometimes used for politeness when must be is really meant.

2. Specifications(what is required of something)

   The steel should not contain more than 0.5% of carbon.

   The maximum internal diameter should be 40 thousandths of an inch.

3. Expectations

   The process of cooling should continue for several hours.

   This building should be completed by the end of next year.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What could give a satisfactory joint for light articles of steel?
2. What is the simplest method of welding two pieces of metal together?
3. What is the temperature that could make the metal plastic?
4. In order to get a fairly thick bar of metal, what kind of weld should be normally employed?
5. What kind of welding should be employed in welding sheets or plates of metal together?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. (　) copper	A) 接合
2. (　) brass	B) 紫铜
3. (　) braze	C) 硬焊
4. (　) electrode	D) 金属的
5. (　) metallic	E) 黄铜
6. (　) filler	F) 填充物
7. (　) overlap	G) 焊条
8. (　) joint	H) 搭接

Ⅲ. Change these active statements into impersonal passive statements.

1. We can cast this type of metal into very complicated shapes.
2. We smelt the ore in a blast furnace and reduce it to pig iron.
3. A skilled operator can carry out many operations on a lathe.
4. We clamp the two metal plates together.
5. Coal miners produce millions of tons of coal every week.
6. The company mark several new products every year.
7. They will start production on the new type of reactor soon.
8. We can generate heat for welding in several ways.
9. We pass an electric current across the electrodes.
10. Welders normally prefer a vee-shaped weld.

Ⅳ. Decide on the exact meaning of should in these statements, and complete them. Some examples are in the passive. Occasionally more than one meaning is possible.

1. This experiment(________ give) us the answer of the problem.
2. The mould(________ be) slightly larger than the casting we want.
3. Smoking(________ permit) within fifty yards of the store.
4. High tensile steels(________ temper) up to 600℃.
5. The new reactor(________ be) in operation in 1968.
6. A flux(________ apply) to the heated metal to prevent oxidation.
7. The motorway(________ have) three lanes in each direction with a reservation in the middle.
8. The results of the experiment(________ write) up carefully.
9. Wear on the bearings(________ reduce) considerably with good lubrication.
10. The heated metal(________ allow) to cool slowly over a long period.

Reading 2: Cracking and Fracture in Welds

The severe make it cycle and the high restraints involved in welding thick, strong metals make it inevitable that cracking problems sometimes occur.

1. Those attributed to the welding process itself.
2. Those occurring during service.

The latter is mainly concerned with external factors that can degrade the weld and cause cracking, such as the effects of environment, vibration or thermal cycling. In this chapter only the former category is considered, i. e. those that arise from the process of welding itself, including reheat annealing.

The types of cracking phenomena associated with the welding process include:

1. Hydrogen attack(weld deposit).
2. Gas porosity(weld deposit).
3. Solidification cracking(weld deposit).
4. Liquation cracking, HAZ burning or hot tearing(fusion zone).
5. Lamellar tearing(HAZ).
6. Cold cracking or hydrogen cracking(HAZ).
7. Reheat cracking(weld deposit and HAZ).

Of course, the most interesting with respect to complexity and severity is usually considered to be solidification cracking, liquation cracking, lamellar tearing, cold cracking and reheat cracking, and these phenomena are the main concern herein. As a basis for discussion of the mechanisms of cracking in the various cases, it is first useful to consider the question of what constitutes the crack resistance, or fracture toughness, of a material and how welding can affect this property.

Fracture Toughness

It is usual in engineering to talk of ductile or brittle fracture. Examples of the fracture surfaces from ductile and brittle failures in steels are shown in Fig. 2. 1. The ductile failure is characterized by 'dimpling' of the surface due to localized plastic flow occurring around small inclusions, Fig. 2. 1(a). The brittle cleavage fracture surface, on the other hand, appears comparatively flat and featureless and exhibits little or no evidence of plasticity, Fig. 2. 1(b). In an optical stereomicroscope, the brittle cleavage fracture is easily recognized because of the brightly reflecting characteristics of the freshly broken transcrystalline (usually $\{100\}_\alpha$)surface facets. If, on the other hand, fracture is intercrystalline, i. e. the fracture path has followed along grain boundaries, the fracture surface is less bright and the grain shapes are recognizable, Fig. 2. 1(c).

As a general rule, high fracture toughness is associated with the amount of energy it takes for a crack to propagate through the material, and this in turn is roughly proportional to its path length and the energy of plastically deformed material(compare, e. g. Fig. 2. 1 (a)and(b)). Fracture toughness is thus mostly concerned with distinguishing between the conditions that characterize high and low crack resistances in materials, and thereby with defining the exact condition under which brittle fracture occurs. For an excellent introduction to this subject, as applied to welding. Although the existence of a crack or sharp notch is a necessary prerequisite for brittle failure, its mere presence is no guarantee that brittle failure, its mere presence is no guarantee that brittle failure results, as is shown later.

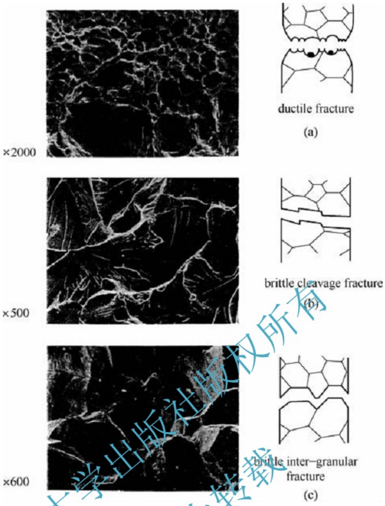


Fig. 2.1 Fracture surfaces

Consider a notched sample under a uniaxial tensile stress, σ_{app}, as shown in Fig. 2.2 (a). The notch or crack induces a stress intensity profile with the principal stresses σ_{xx}, σ_{yy} and σ_{zz}. Under what condition can the crack grow in length? If the metal is ductile, the region at the crack tip deforms plastically under the influence of the high stress intensity (σ_{yy}), and this causes the crack faces to move apart. The more ductile the metal, the larger the plastic zone at the crack tip becomes. Suppose now that the material is sufficiently hard that growth of the plastic zone is restrained by the surrounding material. This restraint causes secondary elastic stresses to build up around the crack tip, both at right angles to the applied stress in the plane of the crack(σ_{zz}), and also parallel to the crack face (σ_{xx}). Thus, a triaxial state of tensile stress is developed. The state of triaxial stress which allows no contraction or strain in the through - thickness direction is defined as a condition of plane strain. Fig. 2.2(b). If there are no restraints developed in the thickness direction the condition is defined, instead, to be one of plane stress, Fig. 2.2(c). Thus,

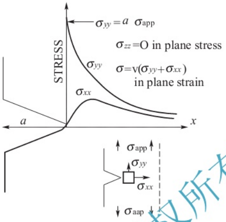
$$\sigma_{zz}=0 \tag{2.1}$$

equation(2.1)can be applied to the case of plane stress and equation(2.2)to

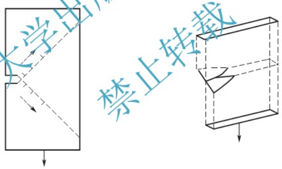
$$\sigma_{zz}=v(\sigma_{yy}+\sigma_{xx}) \tag{2.2}$$

that of plane strain, where v is Poisson's ratio. On this basis it can be concluded that, if the sample is thick enough, a notch can bring about a trixial state of stress which locally

increases the yield stress of the material ahead of the crack. Since the conditions that give rise to restraint increase if the thickness(xz) of the material is larger or if the plastic zone is smaller, it follows that a triaxial stress is more likely to occur in thicker sections or harder material. The possible ways of hardening the material are by decreasing the temperature, increasing the rate of loading or changing the microstructure.



(a) stresses at a notch



(b) plane strain (c) plane stress

Fig. 2. 2 (a) The elastic stress distribution in a notched specimen. After Knott, J. F. Second phase particles and the toughness of structural steels. Effect of Second－phase Particles on the Mechanical Properties of Steel. Iron and Steel Institute, London, 1971. (b) and (c) Comparison between plan－strain and plain－stress fracture in ductile metals. After Cottrell. A. H. Mechanical Properties of Matter. John Wiley, 1964

参考译文：

Reading 2 焊接接头中的裂缝与裂痕

焊接厚度大和强度高的金属时会产生高约束(力)，这不可避免会时而出现裂缝的问题，且更为严重的是这一现象会循环出现。

1. 这些问题都归因于焊接工艺本身。

2. 这些都是使用期间发生的问题。

后者主要和降低焊缝强度和导致其裂缝的外部因素有关，如环境振动或者热循环等因素的影响。本章仅考虑第一类，即那些由于焊接工艺过程本身所引起的因素，包括重新加热退火。

与焊接过程有关的典型断裂现象，包括：

1. 氢化学反应侵蚀(焊缝堆积)。

2. 气孔(焊缝堆积)。

3. 凝固裂纹(焊缝堆积)。

4. 偏析裂纹，热影响区燃烧或者热撕裂(熔化区)。

5. 层体状撕裂(热影响区)。

6. 冷却开裂或者氢蚀裂化(热影响区)。

7. 再加热裂纹(焊缝堆积和热影响区)。

当然，关于热复杂性和严重性，最令人关注的是正常反应的固化裂纹、偏析裂纹、层体状撕裂、冷却开裂和再加热裂纹，而且这些现象是本文主要关心的问题。作为谈论各种情况下裂缝机理的一个基础，讨论什么构成材料裂缝阻力或材料断裂韧性的问题和焊接如何能影响这一特性的问题是最实用的。

断裂韧度

在工程中讨论韧性或者脆性断裂是很平常的。来自钢材韧脆性失效的裂断表面的几个例子正如图 2.1 所示。由于限定材料塑性流动集中发生在小夹物周围，所以韧性失效是以表面韧窝陷窝为特征的，如图 2.1(a)所示。另一方面，脆性解理断裂表面相对来说显得光泽，无什么明显特征，并且很少或没有呈现任何塑性外观迹象，如图 2.1(b)所示。因为刚刚破裂的横晶(通常 $\{100\}_{\alpha}$)小断面有光电反射的特点，在一个体式光学显微镜下，脆性解理断裂是很容易被识别的。另一方面，如果断裂是沿晶界的，即断裂的路径是沿着晶体的界面，那么断裂的表面就不会那么光亮，晶粒的形状便可以被识别，如图 2.1(c)所示。

一般说来，高的断裂韧性与遍及整个材料的裂纹所需求的能量有关，并且这也与它的路径长度和使材料发生塑性变形的能量大体上成比例(如比较图 2.1(a)和(b))。这样断裂韧性通常主要是与区分有关材料裂纹阻力的高低为特征的，由此，随之给出了脆性断裂产生的准确条件的定义。对这一问题的极好的引介，同样适用于焊接。对于脆性失效而言，尽管裂纹或者尖锐缺口的存在是其产生的必要先决条件，但是它的存在只不过没有脆性失效及后果的迹象，正如稍后所显示。

如图 2.2(a)所示，考虑在一个单轴拉伸应力 σ_{app} 作用下的并有切口的一个试件，切口或裂纹诱导一个主应力 σ_{xx}、σ_{yy}、σ_{zz} 的应力强度分布图。在什么条件下裂纹长度可能有所增长呢？如果是韧性金属的话，那么裂纹的尖端区域就会在高应力强度(σ_{yy})的影响下发生塑性变形，这引起裂纹前面分离。金属韧性越强，裂纹尖端的塑性区域就会越大。现在假如金属足够坚硬以至于塑性区域的生长被周围的材料限制，这种限制就会在裂缝尖端周围建立起二次弹性应力，即在裂纹平面内成直角施加应力(σ_{zz})，也平行于裂纹端面(σ_{xx})，这样，形成了一个三面的张应力状态。这种允许在整个厚度方向无收缩或应变的三轴应力状态被定义为平面应变条件，如图 2.2(b)所示。假如在厚度方向没有形成约束，则这种

条件定义为平面应力状态，如图 2.2(c)所示，因此，等式(2.1)可适用于平面应力，等式(2.2)适用于平面应变，式中 v 是泊松比率。以此为依据，我们可以得出结论：如果样本足够厚，切口可能引起三轴向应力状态，这种状态会局部地增加裂纹前方材料的屈服应力。因为如果材料越厚或者塑性区域越小，产生约束阻力的条件就会增加，则得出结论：三轴应力更有可能出现在较厚的零部件截面上或者较硬的材料中。使材料可能硬化的方法是降低温度，增加载荷速率，或者改变微观结构。

Unit 3

Text 3: Cutting Angles

In Fig. 3.1(a), it is clear that the lower surface of the tool (called the *flank*) makes an angle ψ with the newly machined surface of the workpiece. This angle is essential for the elimination of friction between the flank and the newly machined surface. We can also see in Fig. 3.1(b) that there is an angle γ between the upper surface of the tool along which chips flow (this surface is called the *face*) and the plane perpendicular to the machined surface of the workpiece. It is easy to realize that the angle γ indirectly specifies the slope of the tool face. That angle is known as the *rake angle*[1], and it is necessary for shoveling the chips formed during machining operations. In fact, the resistance to the flow of the removed chips depends mainly upon the value of the rake angle. As a consequence, the quality of the machined surface also depends on the value of the rake angle. In addition to these two angles, there is the wedge angle or tool angle, which is the angle confined between the face and the flank of the tool[2]. You can see from Fig. 3.1(b) that the algebraic sum of the rake, tool, and clearance angles is always equal to 90°. Therefore, it is sufficient to define only two

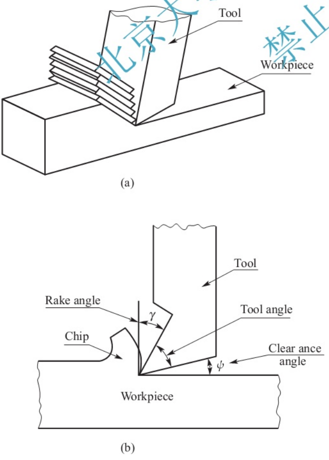


Fig. 3.1 Tool angles in two-dimensional cutting

of these three angles. Actually, in metal-cutting practice, the rake and the clearance angles are the ones that are defined.

As you may expect, the rational or recommended values for the rake and the clearance angles are mainly dependent upon the nature of the metal-cutting operation and the material of the workpiece to be machined. The successful choice of proper values for these two angles would result in the following gains:

1. Improved quality of the machined surface.
2. A decrease in the energy consumed during the machining operation. That energy is mostly converted into heat.
3. Longer tool life as a result of a decrease in the rate of tool wear, since the elapsed heat would be reduced to minimum.

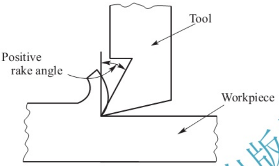


Fig. 3. 2 Positive rake angle required when machining soft, ductile metals

Let us now discuss briefly how the mechanical properties of the workpiece material would affect the optimum value of the rake and clearance angles. Generally, soft ductile metals require tools with larger positive rake angles to allow easy flow of the removed chips on the tool face, as shown in Fig. 3. 2. In addition, the higher the ductility of the workpiece material, the larger the clearance angle of the tool that is needed, in order to reduce the part of the tool that will "sink" into the workpiece(i. e. reduce the area of contact between the tool flank and the machined workpiece surface). On the other hand, hard, brittle materials require tools with smaller or even negative rake angles in order to increase the section of the tool subjected to the loading, thus enabling the tool to withstand the high cutting forces resulting in that case[3]. Fig. 3. 3 illustrates tools having zero and negative rake angles required when machining hard, brittle alloys. In that case, the clearance angle is usually taken smaller than that recommended when machining soft, ductile materials[4].

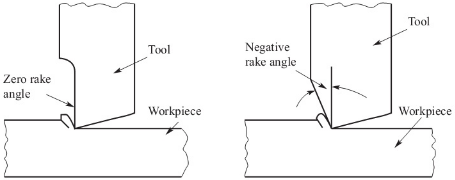


Fig. 3. 3 Zero and negative rake angles required when machining hard brittle materials

Words and Expressions

1. flank	[flæŋk]	主后刀面
2. workpiece	['wəːkpiːs]	工件
3. plane	[plein]	平面
4. machined surface		已加工表面
5. chip	[tʃip]	切屑
6. face	[feis]	前刀面
7. perpendicular	[ˌpəːpən'dikjulə]	*a.* 垂直的，成直角的 *n.* 垂线，垂直面
8. specify	['spesifai]	*v.* ① 具体指定，明确说明 ② 把...列入说明书(或清单等)
9. slope	[sləup]	斜度，斜率
10. rake angle		前角
11. shovel	['ʃʌvəl]	*v.* 用铲铲(起)，用铁锹挖 把...扔进(或塞进) *n.* 铲子，铁锹
12. resistance	[ri'zistəns]	*n.* ① 抵抗，反抗 ② 抵抗力，抗性，耐性 ③ 抵制，阻力 [(＋to)]
13. remove	[ri'muːv]	*v.* ① 移动，搬开，调动 ② 去掉，消除
14. value	['væljuː]	*n.* 数值
15. wedge angle		刀尖切角
16. tool angle		刀具角度
17. confine	[kən'fain]	*v.* 限制，使局限
18. algebraic	[ˌældʒi'breiik]	*a.* 代数的，代数学的，代数上的
19. clearance angle		后角
20. sufficient	[sə'fiʃənt]	*a.* 足够的，充分的
21. metal－cutting		金属切割
22. rational	['ræʃənəl]	*a.* 理性的，有理性的，明事理的
23. recommend	[ˌrekə'mend]	*v.* ① 推荐，介绍 ② 建议，劝告
24. consume	[kən'sjuːm]	*v.* 消耗，花费，耗尽
25. convert	[kən'vəːt]	*v.* 转变，变换
26. tool life		工具耐用度
27. tool wear		工具磨损
28. elapse	[i'læps]	*v.* (时间)过去，消逝

29. mechanical [mi'kænikəl] a 机械的，用机械的
30. property ['prɔpəti] n. ① 财产，资产，所有物，地产
② 特性，性能，属性
31. optimum ['ɔptiməm] a. 最大限度，最理想的
32. ductile ['dʌktail] a. 易延展的，柔软的
33. positive rake angle 正值前角
34. negative rake angle 负值前角
35. zero rake angle 零度前角
36. subject ['sʌbdʒikt] v. ① 使隶属，使服从
② 使蒙受，使遭遇
n. 主题，题目，题材
a. 易受...的，易患...的
37. loading ['ləudiŋ] n. 装载的货，载荷
38. withstand [wið'stænd] v. 抵挡，反抗，禁得起
39. cutting force 切削力
40. alloy ['ælɔi] n. 合金
v. 使...成合金
41. as a consequence 因而，结果
42. in addition to 另外
43. be dependent upon 依赖于
44. in that case 既然那样

Notes

1. 金属切削加工是使用高于工件硬度的刀具，在工件上切除多余金属，使工件达到规定的几何形状、尺寸精度和表面质量的一种机械加工方法。本篇课文涉及切削刀具中切削角度的基础知识，课文题目：切削角度。

2. 前角(rake angle)是在正交平面内测量的前刀面和基面之间的夹角。前角有正、负和零度之分。若前刀面在基面之上为正值，前刀面在基面之下为负值，基面与前刀面重合为零度前角。后角(clearance angle)是正交平面内测量的主后刀面和切削平面之间的夹角。刀尖切角(wedge angle)是前刀面与主后刀面之间的夹角。

3. On the other hand, hard, brittle material require tools with smaller or even negative rake angles in order to increase the section of the tool subjected to the loading, thus enabling the tool to withstand the high cutting forces resulting in that case.

本句的句子较长，句子成分较为复杂，需要抓住句子主干，才能理解其意。在该句中，hard, brittle material 是主语，require 是谓语动词，tools 是宾语，with smaller or even negative rake angles 则作为宾语补足语，in order to 后所接的成分是目的状语，subjected to the loading 则是 tools 的后置定语，enabling the tool to withstand the high cutting forces resulting in that case 作原因状语。本句可译为：相反，硬度高的、韧性较

差的工件材质要求刀具前角越小越好，甚至负值前角，目的是增加刀具与工件的接触面积，使刀具能够经受住大的切削力。

4. In that case, the clearance angle is usually taken smaller than that recommended when machining soft, ductile material. 本句中的重要语法项目是比较状语从句中的替代问题。代词 that 代替 the clearance angle，过去分词 recommended 作 that 的后置定语，when machining soft, ductile material 作时间状语。

在比较状语从句中，名词或动词和主句中相应的名词或动词完全一样时，可用 one，that，those，do 来代替重复的名词或动词。

(1) that 可以来代替可数名词或不可数名词，但常用于替代不可数名词，其复数形式为 those。通常使用 that of 或 those of。

(2) one 和 ones 只代替可数名词，that 和 those 替代一个词组。

(3) 助动词 do(did)可用来替代重复的谓语动词。

本句可译为：当切削韧性较好、延展性较强的工件时，实际后角比理论所需要的取得小。

Word-Study

***en* –(*or em* –)**

The prefix en –(or em –, before b and p) can be added to nouns or objectives to form verbs with the meaning "put in", "give... to", "cause to be", etc.

e. g. sure—ensure   tangle—entangle   large—enlarge   able—enable

Sentence Patterns

Ⅰ. It is/was+adj. +that/for/to

It is/was	clear	that	the lower surface of the tools(called the flank) makes an angle with the newly machined surface of the workpiece.
It is/was	necessary	for	shoveling the chips formed during machining operations.
It is/was	sufficient	to	define only two of these three angles.

Ⅱ. Angle

The lower surface of the tool(called the flank) makes an angle with the newly machined surface of the workpiece.

There is an angle between the upper surface of the tool and the plane perpendicular to the machined surface of the workpiece.

The tool angle is the angle confined between the face and the flank of the tool.

... makes an angle with...

There is an angle between... and...

… is the angle confined between... and...

Exercises

Ⅰ. Give brief answers to the following questions.

1. What are the definitions of the rake, tool and clearance angles?
2. What does the resistance to the flow of the removed chips depend mainly on?
3. What is the algebraic sum of the rake, tool, and clearance angles always equal to?
4. What gains would the successful choice of proper values for the rake and the clearance angles result in?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) flank	A) 工具耐用度
2. ( ) workpiece	B) 前角
3. ( ) face	C) 前刀面
4. ( ) machined surface	D) 工具磨损
5. ( ) rake angle	E) 工件
6. ( ) wedge angle	F) 已加工表面
7. ( ) clearance angle	G) 锻造法
8. ( ) tool life	H) 主后面
9. ( ) tool wear	I) 切削力
10. ( ) cutting force	J) 后角

Ⅲ. Now form verbs by adding en-(em-) to the words given below and then complete the following sentences with one of the verbs formed in this way.

sure	tangle	large	able

1. The shaft must ________ to sustain a combination of bending and torsional loads.
2. Long, thin curled chips, if they cannot be broken up with a chip breaker, can interfere with the operation by becoming ________ in the cutting area.
3. Manipulating a graphic image means ________, reducing, rotating, or moving the image or portions of it.
4. Traces can be easily checked to ________ that all connections have been properly laid out.

Ⅳ. Fill in each of the blanks in the following sentences with words or phrases given below. Change the forms where necessary.

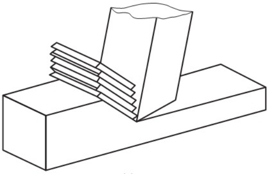
require	perpendicular	brittle	convert	ductile	as a consequence

1. The energy consumed in plastically deforming the metal is eventually ________ into heat and lubricants.
2. The direction of motion of the tool(relative to the workpiece)is always ________ to its straight cutting edge.
3. When machining soft, ________ metals such as low-carbon steel, copper, and

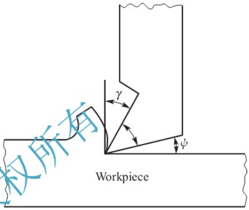
aluminum at the recommended cutting speed, which are high, the plastic flow becomes dominant instead of shearing.

4. This material is highly ________ .
5. ________ , the chip takes the form of a long, twisted ribbon.
6. A machine tool is ________ to provide proper support to the workpiece and cutting tools.

Ⅴ. Fill in the blanks using the proper words in this unit.



(a)



(b)

Ⅵ. Correct Errors

1. <u>A</u> material with good machinability is <u>one</u> requiring low power consumption, <u>with</u> low tool wear, and <u>producing</u> a good surface finish with no surface damage.
A — B — C — D

2. A material producing such a chip <u>is</u> <u>less</u> machinable than <u>ones</u> with breakable or discontinuous <u>chips</u>.
A — B — C — D

3. The theory[1] was based on the <u>assumption</u> that a crack would be <u>initiated ahead</u> of the cutting edge and would <u>propagate</u> in fashion similar to <u>those</u> of the splitting of wood fibers.
A — B — C — D

4. Our <u>rules</u> are quite different <u>from</u> <u>that of</u> <u>other organizations</u>.
A — B — C — D

Note: [1] The theory is from Reuleaux. There was an early attempt by Reuleaux at the beginning of the twentieth century to explain the mechanics of chip formation. He established a theory that gained popularity for many years.

Reading 3: Classification of Machine Tools

There are many ways in which machine tools can be classified. One such classification

based on production capability and application is given in the following lines.

General purpose machine tools(GPM)

These tools are those designed to perform a variety of machining operations on a wide ranging type of components. By its very nature of generalisation, a general purpose machine tool though capable of carrying out a variety of tasks, would not be suitable for large production, since the setting time for any given operation is large. Thus the idle time on the general purpose machine tool is more and the machine utilisation is poor. Machine utilisation may be termed as the percentage of actual machining(chip generating)time to the actual time available. This is much lower for general purpose machine tools. They are also termed as basic machine tools.

Skilled operators would be required to run general purpose machine tools. Hence their utility is in job shops(catering to small batch, large variety job production)where the requirement is versatility rather than production capability. Examples are lathe and milling machine.

Production machine tools

These are those machine tools where a number of functions are automated such that the operator skill required to produce the component is reduced. This helps in reducing the idle time of the machine tool thus improving the machine utilisation. A general purpose machine tool may also be converted into a production machine tool by using jigs and fixtures for holding the workpiece. Production machine tools have been developed from basic machine tools. Some examples are capstan and turret lathes, automatic and multiple spindle drilling machines. Their setting time for a given job is more and the tooling design for a given job is more time consuming and expensive. Hence they are useful only in case of a large volume of production.

Special purpose machine tools(SPM)

These are those machine tools where the setting operation for the job and tools is practically eliminated and complete automation is achieved. This greatly reduces the cycle time (the actual manufacturing time)of a component and helps in the reduction of costs. These are used for mass manufacturing. These machine tools are expensive compared to general purpose machines since they are specifically designed for the given application, and are restrictive in their application capabilities. Examples are cam shaft grinding machine, connecting rod twin boring machine and piston turning lathe.

Single purpose machine tool

These machine tools are those which are designed specifically for doing a single operation on a class of jobs or on a single job. They have the highest amount of automation and are used for high rates of production. These machine tools are used specifically for one product only and thus have the least flexibility. However they do not require any manual intervention and are the most cost effective. Examples are transfer lines composed of unit heads for completely machining any given product.

The application of these four types of machine tools has been shown graphically

in Fig. 3. 4

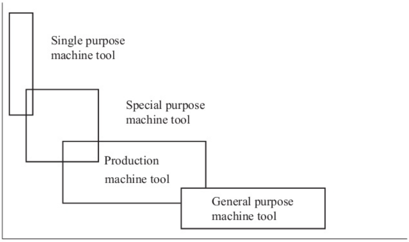


Fig. 3. 4 Application of machine tools based on their capability

参考译文:

Reading 3 机械加工刀具的分类

机械加工刀具的分类有很多种方法，其中一种方法是基于生产能力和应用而分的，主要有以下几种种类。

通用刀具

这类刀具能够对很多种零件进行各种各样的机械加工。由于它的这种通用性，通用刀具能够完成各种工作，因此不适用于大量生产。这是因为刀具的任何操作安装时间都很长，通用刀具的待工时间就会延长，刀具的使用率相应就会降低。机器使用率可以定义为实际机器操作时间(形成切屑)与实际使用时间之间的百分比。通用刀具的机器使用率很低。通用刀具也被称为基本刀具。

通用刀具要求由熟练技工操作。需要在加工车间里使用(适用于小批次、多种类的生产)。在加工车间里主要满足刀具的多用途性而不是高效性，比如车床和铣床。

生产刀具

生产刀具有很多自动化功能，比如，它降低了操作者在生产零件时所要求掌握的技术，减少了刀具的待工时间，从而改善了刀具的使用率。通过使用夹具和支架夹住工件，通用刀具也就转变成为由基本刀具发展而来的生产工具，如，绞盘和转塔车床，自动多轴钻床。刀具的安装时间增加，刀具设计的时间延长，费用提高，因此，它只适用于大批量的生产。

特殊用途刀具

特殊用途刀具使用过程中的设置和刀具调整等操作几乎被取消，从而实现完全自动化。这很大程度上减少了循环时间(实际的生产时间)，降低了生产成本，适用于大量生产。特殊用途刀具与通用刀具相比更加昂贵，这是因为它们是为了特定的应用而设计，而且应用能力也有所限制，比如凸轮轴磨床、双连杆镗床和活塞旋转

车床。

单一用途刀具

单一用途刀具是为了完成某一类或是某一项工作的单一操作而设计的，实现了最大程度的自动化，并达到了最高的生产效率。这些刀具只适用于某一项生产，因此适用性很差。尽管如此，它们不需要任何手工介入，成本低、效率高。

这四种机械加工刀具的应用如图 3.4 所示。

Unit 4

Text 4: Lathes

Lathe is one of the most fundamental and versatile machine tools with a large number of uses in all manufacturing shops. It is designed primarily to do turning, facing, drilling, reaming and boring. Its versatility permits several operations to be done with a single setup of the workpiece

The principal form of surface produced in a lathe is the cylindrical surface. This is achieved by rotating the workpiece while the single point cutting tool removes the material by traversing in a direction parallel to the axis of rotation and termed as turning as shown in Fig. 4. 1. The popularity of the lathe due to the fact that a large variety of surfaces can be produced.

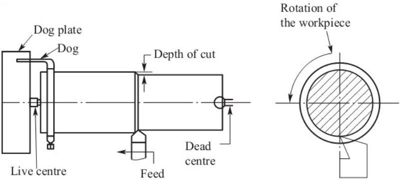


Fig. 4. 1　Cylindrical turning operation in a lathe

A typical centre lathe is shown in Fig. 4. 2. The essential components of a lathe are the bed, headstock assembly, tailstock assembly, carriage assembly, and the leadscrew and feed rod.

The bed is the backbone of a lathe. It usually is made of well - normalized or aged gray or nodular cast iron and provides a heavy, rigid frame on which all the other basic components are mounted. Two sets of parallel, longitudinal ways, inner and outer, are contained on the bed, usually on the upper side.

The headstock is towards the left - most end on the bed and is fixed to it, which

houses a hollow spindle mounted in accurate bearings and a set of transmission gears through which the spindle can be rotated at a number of speeds.[1] An increasing trend is to provide a continuously variable speed range through electrical or mechanical drives.

The accuracy of a lathe is greatly dependent on the spindle. The spindle has a hole extending through its length, through which long bar stock can be fed. The size of this hole is an important dimension of a lathe because it determines the maximum diameter of bar stock.

The tailstock is towards the right – most end on the bed for the purpose of locating the long components by the use of centres. The tailstock is movable on the inner guideways provided on the bed to accommodate the different lengths of workpieces. It also serves the purpose of holding tools such as centre drill, twist drill reamer, etc. For making and finishing holes in the components which are located in line with the axis of rotation.

The third major element in the lathe mechanism is the carriage, which provides the necessary longitudinal motion to the cutting tool to generate the necessary surfaces. This also houses the cross – slide for giving the motion(cross feed) to the cutting tool in a direction perpendicular to the axis of rotation the compound slide which provides an auxiliary slide to get the necessary special motion or specific surface generations and the tool post which allows for the mounting of the cutting tool.

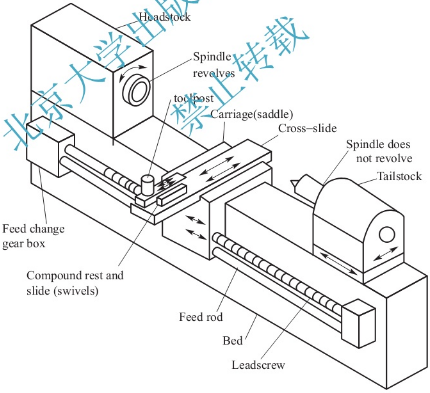


Fig. 4. 2 General view of a centre lathe showing various mechanisms and features

The motion from the spindle motor is communicated to the carriage through a lead screw. Engagement of the lead screw with the carriage is through the use of a half nut. Though the lead screw could be used for feeding the cutting tool in a direction parallel to the axis of rotation, many a time a separate feed rod is provided for this function. The main reason is that the lead screw is more accurate and is used only for thread cutting,

such that it maintains its accuracy. For routine feeding, the feed rod is used.

Words and Expressions

1. lathe	[leið]	*n.* ①车床 ②[纺] 走梭板 *v.* 用车床加工
2. lead screw		丝杠
3. feed rod		光杠
4. primitive	['primitiv]	*a.* ①简单的 ②基本的 ③原始的
5. fundamental	[ˌfʌndə'mentl]	*a.* ①基础的，基本的 ②至关重要的
6. versatile	['vəːsətail]	*a.* ①多用途的，多功能的 ②通用的
7. traverse	['trævəːs]	*v.* ①旋转 ②横渡 ③越过，穿过
8. thread cutting		螺纹加工
9. feed	[fiːd]	*v.* 进给
10. clamp	[klæmp]	*v.* ①夹紧，夹住 ②固定
11. mount	[maunt]	*v.* ①安装 ②设置 ③登上，爬上
12. rigid	['ridʒid]	*a.* ①刚性的 ②固定的 ③严格的
13. conventional	[kən'venʃənl]	*a.* ①传统的 ②常规的 ③惯例的
14. house	[hauz]	*v.* ①嵌入 ②给(齿轮等)装外罩
15. accessory	[æk'sesəri]	*n.* (pl.)accessories 附件
16. attachment	[ə'tætʃmənt]	*n.* 附属装置
17. headstock	['hedstɔk]	*n.* 主轴箱
18. tailstock	['teilstɔk]	*n.* 尾座
19. component	[kəm'pəunənt]	*n.* 部件
20. guideway	['gaidwei]	*n.* 导轨
21. reamer	['riːmə]	*n.* 铰刀
22. carriage	['kæridʒ]	*n.* 溜板箱
23. engagement	[in'geidʒmənt]	*n.* (齿轮等的)啮合
24. manufacturing shop		生产车间
25. cylindrical surface		圆柱表面

Notes

1. The headstock is towards the left - most end on the bed and is fixed to it, which houses a hollow spindle mounted in accurate bearings, and a set of transmission gears through which the spindle can be rotated at a number of speeds. 该句中第一个 which 引导的非限制性定语从句，其对前面所说内容起到补充说明的作用。第二个 which 引导的定语从句修饰 transmission gears。全句译为：主轴箱位于车床床身的最左端并固定于其上，主轴箱内有装在精密轴承上的中空的主轴，以及一系列的传动齿轮，这些传动齿轮可以使主轴获得多种转速。

Word - Study

Ⅰ. *Reach*, *Attain*, *Achieve*

1. The aircraft is capable of $\left\{\begin{array}{l}\text{reaching}\\ \text{attaining}\\ \text{achieving}\end{array}\right\}$ a speed of 4000 miles per hour.
2. An efficiency of only 4% or 5% was attained by the engine.
3. A high degree of accuracy can be achieved by cold - working in the metal.
4. A greater efficiency should be attainable/achievable with certain modification.

Ⅱ. *Produce*, *Product*, *Production*

1. a. The company produces 1000 cars a day.
   b. The boiler produces high - pressure steam.
2. a. Most of our industrial products are sold abroad.
   b. These hot gases are the products of combustion.
3. a. Motor - car production is increasing rapidly.
   b. A new production line will be set up in the factory.

Ⅲ. *Specific*, *Specify*, *Specification*

1. The engineer was given specific instructions on what to do.
2. The terms of employment must be clearly specified in the contract.
3. The specification should include all the information required by the contractor to carry out the work properly.

Sentence Patterns

Ⅰ. Movements

1. a. A trip - lever operates the valve. (=makes it move)
   b. A flexible belt drives the motor. (=makes it turn/work)
2. a. The cross - slide $\left\{\begin{array}{l}\text{traverses}\\ \text{crosses}\end{array}\right\}$ the carriage.
   b. The wheels $\left\{\begin{array}{l}\text{rotate.}\\ \text{turn.}\\ \text{revolve.}\end{array}\right.$
3. a. The machine is $\left\{\begin{array}{l}\text{at rest.}\\ \text{stationary.}\end{array}\right.$
   b. The machine is $\left\{\begin{array}{l}\text{in motion.}\\ \text{moving}\end{array}\right.$

Ⅱ. Purpose

1. The $\left\{\begin{array}{l}\text{purpose}\\ \text{aim}\\ \text{object}\end{array}\right.$ of the safety valve is to allow excess pressure to escape.

2.

A safety valve is provided	to so as to in order to	allow	excess pressure to escape.
	for the purpose of with the aim of with the object of	allowing	

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is the major form of surface produced in a lathe?
2. What are the major elements in the lathe mechanism?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) thread cutting	A) 卡盘
2. ( ) feed gear box	B) 螺纹切割
3. ( ) capstan and turret lathe	C) 专用车床
4. ( ) tool room lathe	D) 进给齿轮箱
5. ( ) lead screw	E) 丝杠
6. ( ) special purpose lathe	F) 工具车床
7. ( ) dog plate	G) 六角转塔车床

Ⅲ. Finish the following sentences by using *purpose*, aim, or *object*.

1. The ________ of fitting water-tubes in a boiler is to absorb some of the heat.
2. The ________ of working the metal cold is to obtain a more accurate finish.
3. The ________ of using firebricks is to minimize heat losses in the boiler.
4. The ________ of the test is to calculate the total temperature rise.
5. The ________ of a large heating surface is to increase the amount of the steam which is produced.

Ⅳ. Fill in each of the blanks in the following sentences with words in Word Study. Change the forms where necessary.

1. One means which is often used to ________ this is to operate the machine quickly.
2. Combustion ________ very hot gases.
3. Recent ________ figures show an improvement on last year.

4. Pressure of up to 300 pounds per in^2 was ________ in the boiler.
5. Petrol and kerosene are ________ of crude petroleum.
6. To ________ the goal of reaching a speed of 360 miles per hour is not very difficult.
7. The exact dimensions and tolerances should be ________ by the customer.

Reading 4: Accessories of Lathes

Chuck

The most common form of work holding device used in a lathe is the chuck. Chucks come in various forms with varying number of jaws. Of these the 3 – jaw chuck or the self centring chuck as shown in Fig. 4. 3 is the most common one. The main advantage of this chuck is the quick way in which the typical round job is centered. All the three jaws mesh with the flat scroll plate. Rotating the scroll plate through a bevel pinion moves all the three jaws radially inward or outward by the same amount. Thus, the jaws are able to centre any job whose external locating surface is cylindrical or symmetrical, like hexagonal. Though it is good for quick centring, it has limitations in terms of the gripping force accuracy which is gradually lost due to the wearing of the mating parts.

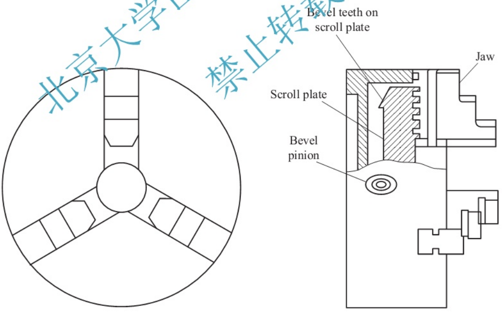


Fig. 4. 3 Structure of a three – jaw chuck

The independent jaw chuck has four jaws, which can be moved in their slots which are independent of each other (Fig. 4. 4), thus clamping any type of configuration. Since each of these jaws can be moved independently any irregular surface can be effectively centreed. Better accuracy in location can be maintained because of the independent movement. However more time is spent in fixturing a component in a 4 – jaw compared to the 3 – jaw chuck. This is generally used for heavy workpieces and for any configuration.

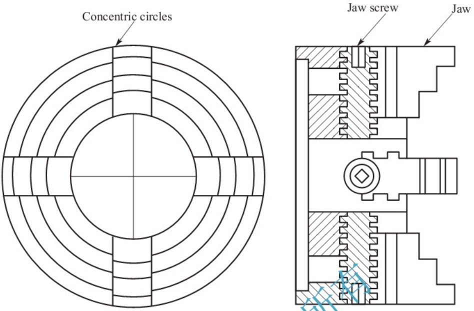


Fig. 4. 4　Structure of a four - jaw chuck

The jaws in a 4 - jaw chuck can be reversed for clamping large diameter workpieces as shown in Fig. 4. 5. The soft jaws are sometimes used in these chucks for clamping surfaces of a component whose surface is already finished and which is likely to be disfigured by the hard surface of the normal jaws used in them.

The three - jaw and four - jaw chucks are normally suitable for short components. However a long component supporting at only one end would make it to deflect under the influence of the cutting force. In such cases the long workpieces are held between centres. The workpiece ends are provided with a centre hole as shown in Fig. 4. 6. Through these centre holes the centres mounted in the spindle and the tail stock would rigidly locate the axis of the workpiece.

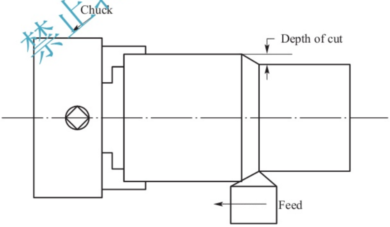


Fig. 4. 5　Chuck and reverse jaw usage

Centres as shown in Fig. 4. 6 would be able to locate the central axis of the workpiece. however would not be able to transmit the motion to the workpiece from the spindle. For this purpose, generally a driver plate and a dog as shown in Fig. 4. 7 would be used. The centre located in the spindle is termed as live centre while that in the tailstock is termed the dead centre. The shank of the centre is generally finished with a Morse taper which fits into the tapered hole of the spindle or tailstock.

The live centre rotates with the workpiece, and hence it remains soft. The dead centre

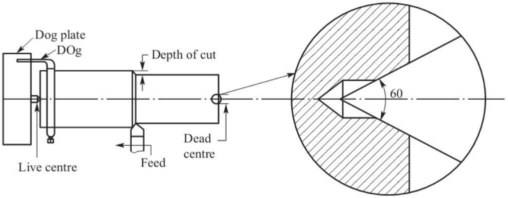


Fig. 4. 6　Centre hole, locating between centres

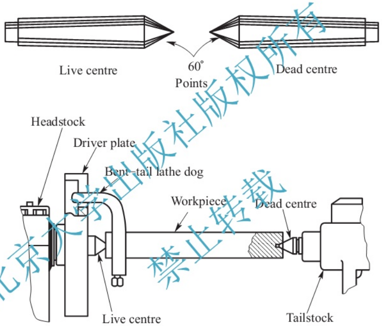
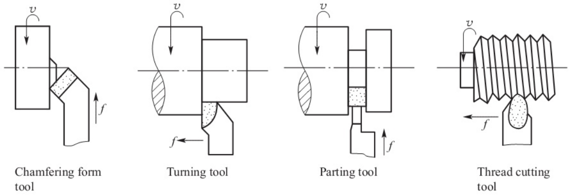


Fig. 4. 7　Driver plate and dog, live centre and dead centre

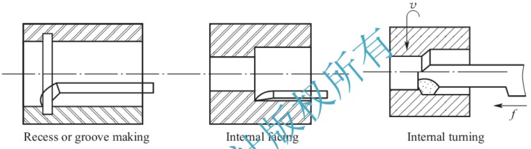
does not rotate, and hence it is overheated when subjected to the high speed and in case of the relative movement between the workpiece and the dead centre causes a large amount of heat generated. In such cases, a revolving centre is used. In this the centre is mounted in a roller bearing and it thus rotates freely, reducing the heat generated at the tailstock end.

Different Types of Tools Used

A large variety of tools are used in centre lathes in view of the large types of surfaces that are generated. The actual type of tool used depends upon the surface of job being generated as well as the workpiece. A variety of tools used for normal generation of external surfaces are shown in Fig. 4. 8(a). Similar tools are available for generating the internal surfaces as well. The choice of a particular tool depends upon the actual surface to be generated as shown in Fig. 4. 8(b).



(a) Different kinds of tools used for external surfaces



(b) Different tools used for internal surfaces

Fig. 4.8 Different types of cutting tools

参考译文：

Reading 4 车床的附件

卡盘

在车床中最普遍使用的工件装夹装置是卡盘，不同数目的卡爪可构成多种形式的卡盘。

其中，三卡爪卡盘或自动定心卡盘应用最普遍，如图 4.3 所示。这种卡盘最主要的优点是它能快速定位回转体类零件的中心。三个卡爪都与平旋盘相啮合，小锥齿轮带动平旋盘旋转，进而使三个卡爪以相同的幅度同时沿径向方向做向心或离心运动。因此，卡爪能将任何具有外圆面和具有对称表面的工件定心，如六角形工件。尽管卡盘有利于快速定位中心，但在啮合力精度方面，依然存在局限性，因为随着啮合的磨损，啮合力精度会逐渐下降。

独立卡爪的卡盘有四个卡爪，这些卡爪能够在彼此独立的槽中移动，如图 4.4 所示，因此可以装夹任何形状的工件。因为任何一个卡爪都能独立移动，所以可以有效地对任何不规则的表面对准中心。这种独立的运动能够较好地保证定位精度。然而和三爪卡盘相比，使用四爪卡盘固定一个工件所花费的时间更多，因此通常用于重型工件和任意结构的工件。

四爪卡盘的卡爪能够反向安装，用于固定如图 4.5 所示的大直径工件，柔性卡爪有时

应用在这种卡盘上可用于固定已经加工完的零件表面，以避免可能由普通卡爪的硬表面而造成的损伤。

三爪卡盘和四爪卡盘通常用于装夹短型工件。然而，对于较长的工件来说，仅对它一端固定会使其在切削力的作用下发生变形，在这种情况下，长工件的两端都要由两顶尖来固定。工件两端带有如图 4.6 所示的顶尖孔。通过这些顶尖孔，使顶尖能够固定轴类工件，同时尾座可以牢固地定位工件轴线。

图 4.6 所示的顶尖能够定位工件的中心轴，然而却不能将主轴运动传递给工件。为了达到这种目的，通常情况下要使用拨盘与卡箍，如图 4.7 所示。位于主轴上的顶尖称为活顶尖，而位于尾座的顶尖则称为死顶尖。顶尖的柄部通常加工成莫氏锥度，这个莫氏锥柄可以安装在主轴或尾座的锥孔内。

活顶尖随工件旋转，因此活顶尖保持有一定的伸缩量，而死顶尖不旋转，因此当它转速较高时容易产生过热的现象。另外，在加工重型工件时，工件和死顶尖间的相对运动产生大量的热量。在这些情况下，通常使用旋转顶尖。顶尖装在滚动轴承中，因而可以自由旋转，减少在尾座端部产生的热量。

不同种类刀具的使用

因为加工多种类型的工件表面，因此普通车床上要使用大量不同种类的刀具，所选刀具的实际类型取决于要加工的工件表面以及工件本身。用于外表面常规加工的各种刀具如图 4.8(a)所示。类似的刀具也用于内表面的加工。具体刀具的选择取决于所要加工的实际表面，如图 4.8(b)所示。

Unit 5

Text 5: NC Machine Tools

Numerical control(often abbreviated NC)can be defined as a form of programmable automation in which the process is controlled by numbers, letters, and symbols. In NC, the numbers form a program of instructions designed for a particular workpart or job. When the job changes, the program of instructions is changed. This capability to change the program for each new job is what gives NC its flexibility. It is much easier to write new programs than to make major changes in the production equipment. [1]

NC equipment is used in all areas of metal parts fabrication and comprises roughly 15% of the modern machine tools in industry today. Since numerically controlled machines are considerably more expensive than their conventional counterparts, the asset value of industrial NC machine tools is proportionally much larger than their numbers.

Basically a NC machine runs on a program fed to it. The program consists of precise instructions about the manufacturing methodology as well as the movements. For example, what tool is to be used, at what speed, at what feed and to move from which point to which point in what path, all these instructions are given. Since the program is the controlling point for product manufacture, the machine becomes versatile and can be used for any part. All the functions of an NC machine tools are therefore controlled electronically, hydraulically or pneumatically.

In NC machine tools one or more of the following functions may be automatic:

1. Starting and stopping of the machine tool spindle.
2. Controlling the spindle speed.
3. Positioning the tool tip at desired locations and guiding it along.
4. Controlling the rate of movement of the tool tip(i. e. feed rate).
5. Changing of tools in the spindle.

Initially the need of NC machines was felt for machining complex shaped small batch components as those belonging to an aircraft. However, this spectrum currently encompasses practically

all activities of manufacturing. The majority of applications of NC are in metal cutting machine tools such as milling machines, lathes, drilling machines, grinding machines and gear generating machines. ; metal forming machine tools such as presses, flame cutting machines, pipe bending and forming machines. The inspection machines called Co – ordinate Measuring Machines(CMM)are also based on NC.

NC machines have been found suitable for the following:

1. Parts having complex contours, that cannot be manufactured by conventional machine tools.

2. Small lot production, often for even single(one off)job production, such as for prototyping, tool manufacturing, etc.

3. Jobs requiring very high accuracy and repeatability.

4. Jobs requiring many set – ups and /or when the set – ups are expensive.

5. Parts that are subjected to frequent design changes and consequently require more expensive manufacturing methods.

6. The inspection cost, which is a significant portion of the total manufacturing cost.

Words and Expressions

1. numerical	[njuː'merikəl]	*a.*	数字的
2. automation	[ˌɔːtə'meiʃən]	*n.*	自动操作，自动化(技术)
3. capability	[ˌkeipə'biliti]	*n.*	①能力，才能 ②容量 ③性能，功能
4. flexibility	[ˌfleksə'biliti]	*n.*	①灵活性 ②机动性；③柔韧性
5. fabrication	[ˌfæbri'keiʃən]	*n.*	生产，制造，加工
6. instruction	[in'strʌkʃən]	*n.*	①指令 ②用法说明，操作指南
7. methodology	[ˌmeθə'dɔlədʒi]	*n.*	方法，方法论
8. part	[pɑːt]	*n.*	部件，零件
9. manufacture	[ˌmænju'fæktʃə]	*n.*	生产，制造，制作
10. position	[pə'ziʃən]	*v.*	安放，安置，放置
11. slide	[slaid]	*n.*	滑板
		v.	滑动
12. machine	[mə'ʃiːn]	*v.*	①机器制造 ②用车床加工
		n.	机械，机器，机构
13. batch	[bætʃ]	*n.*	组，批
14. spectrum	['spektrəm]	*n.*	①范围 ②光谱
15. encompass	[in'kʌmpəs]	*v.*	①包含，包括 ②包围
16. robot	['rəubət]	*n.*	①自动控制装置 ②遥控装置 ③机器人
17. set – up	['setʌp]	*n.*	①装配 ②(材料等的)准备
18. press	[pres]	*n.*	压力机，压床
19. controlling point			控制点
20. feed rate			进给速度

21. metal cutting machine tool	金属切削机床
22. milling machine	铣床
23. drilling machine	钻床
24. grinding machine	磨床
25. gear generating machine	齿轮加工机床
26. metal forming machine tool	金属成型机床
27. flame cutting machine	火焰切割机
28. pipe bending and forming machine	弯管成型机
29. Co - ordinate Measuring Machine (CMM)	三坐标测量机

Notes

It is much easier to write new programs than to make major changes in the production equipment. 这是由 than 引导的比较状语从句。此句中 it 是形式主语，to do sth. 是真正的主语，to write new programs 和 to make major changes 形成比较。全句译为：与在生产设备上做出重大改变相比，编写新的程序要更加容易。

Word-Study

Control*, *Regulate

1. The steam supply to the engine is controlled by the governor.
2. The movement of the valve is regulated by a servo - motor.
3. Working conditions nowadays are regulated by government acts.
4. The temperature in the vessel can be controlled within strict limits.

Sentence Patterns

Ⅰ. Cause

1. The steam pressure falls {because of / on account of / owing to / due to} condensation in the cylinder.

2. {Because of / On account of / Owing to / Due to} the high temperatures, special alloys are used.

Ⅱ. Such as

<table>
<tr><td>1.</td><td colspan="2">Some substances</td><td colspan="2" rowspan="2">such as</td><td>tungsten emit Electrons when heated in a vacuum.</td></tr>
<tr><td>2.</td><td colspan="2">Projects</td><td>this one require a great deal of planning.</td></tr>
<tr><td>3.</td><td rowspan="2">Such</td><td colspan="2">substances</td><td rowspan="2">as</td><td>tungsten emit electrons when heated in a vacuum.</td></tr>
<tr><td>4.</td><td colspan="2">projects</td><td>this one require a great deal of planning.</td></tr>
</table>

5. Soldering is one way of making joints in wire <u>such as</u> occur in electrical work.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What's the definition of numerical control?
2. What does the program that a NC machine runs on/consist of?
3. Where is the majority of applications of NC?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( )milling machine	A) 金属切削机床
2. ( )pipe bending and forming machine	B) 铣床
3. ( )drilling machine	C) 弯管成型机
4. ( )grinding machine	D) 数字控制
5. ( )assembly machine	E) 钻床
6. ( )numerical control	F) 磨床
7. ( )metal cutting machine tool	G) 装配机

Ⅲ. Join the two statements in each line, by using *because of*, *on account of*, *due to* or *owing to*.

1. the high cost of labor, a mechanical stoker was installed.
2. the velocity of a steam, the blades are caused to rotate.
3. expansion of the shaft, misalignment occurs at the bearings.
4. the provision of heat exchangers, the efficiency was increased.
5. the increase in temperature, there is an increase in pressure.
6. their enormous lifting capacity, electro-magnets are used.
7. the wetness of the steam, it must be superheated.
8. the intense stresses involved, a high-carbon steel must be used.
9. dust particles in the atmosphere, accurate observation is very difficult.
10. the expense of the project, government assistance is necessary.

Ⅳ. Fill in each of the blanks in the following sentences with words given below. Change the forms where necessary.

flexibility	instruction	manufacture	capability	position

1. The engineer explained the plane's technical ________ .
2. The worker ________ the metal parts on the control board.
3. The company ________ the well-known machine tools.
4. We appreciate your ________ in dealing with this matter.
5. She operated the new machine according to the ________ .

Reading 5: Manual Programming Methods

The idea of controlling a CNC machine tool is rather simple. A programmer writes a set of instructions describing how he or she would like the machine to move and then feeds the program into the machines computer. The computer reads the instructions and sends electrical signals to a motor which causes the machine table to move and produce the machined part. The instruction is written by Word Address Format in which each of the information or data to be input in the form of numerical digits is preceded by a word address in the form of an English alphabet. For example, N105 means that N is the address for the numerical data 105. Thus the controller can very easily and quickly process all the data entered in this format. A typical block of word address format may look as follows:

N115 S1500 G81 X120.5 Y55.0 Z-12.0 R2.0 F150 M3 T0101

It mainly contains six functions.

1. Coordinate Function

The coordinates of the tool tip are programmed for generating a given component geometry. The coordinate values are specified using the word address such as X, Y, Z, U, V, W, I, J, K, etc. All these word addresses are normally signed along with the decimal point depending upon the resolution(at least 1μm or less for precision CNC machine tools) available in the machine tool. Some examples are:

X120.505 Y55.3 Z-12.0

2. Feed Function

Generally the feed is designated in velocity units using the F word address. For example, F150 means that the feed rate is specified as 150 mm per minute. This is the actual speed with which the tool moves along the programmed path. However, depending upon the programmed path, there could be some deviations in the actual feed followed by the controller. The controller also calculates the actual feed rate of each of the axis.

3. Speed Function

The speed can be set directly in the revolutions per minute mode using the S word address as follows:

S1500 means, that spindle speed is to be set at 1500 rpm.

4. Tool Function

The tool function is normally indicated by the word address T. This may have two or more digits depending upon the tool magazine capacity. In general it is two digits, such as T15. This causes the tool magazine position 15 or tool number 15 to be brought into the spindle, replacing the already present tool in the spindle. The tool replaced from the spindle is brought back to the empty position created when the tool 15 is loaded.

Tool offset, can also be programmed by using the same word T, e. g. T15 13 which means tool no. 15(i. e. tool located in the position 15 in the magazine)is to be loaded in the spindle and the value in offset register 13 is to be taken into account when this tool carries out the operation.

5. Preparatory Functions

This is denoted by 'G' . It is a pre-set function associated with the movement of machine axes and the associated geometry. It has two digits, e. g. G01, G42, and G90 as per ISO specifications. However, some of the current day controllers accept up to three or four digits.

6. Miscellaneous Functions, M

These functions actually operate some controls on the machine tool and thus affect the running of the machine. Generally only one M code is supposed to be given in a single block. However, some controllers allow for two or more M codes to be given in a block, provided these are not mutually exclusive, e. g. , coolant "ON" (M07)and "OFF" (M09) can not be given in one block.

The number of M codes standardized by ISO is less compared to G codes in view of the direct control exercised by these on the machine tool.

7. Program Number

In many of CNC systems, there is a provision for labeling the program at the beginning itself which facilitates searching from stored programs. The symbol used for the program number in Fanuc controls is "O" or ":", followed by its number. For example, O238 or: 238. Such information does not interfere with the NC program.

参考译文：

Reading 5　手工编程方法

控制一台 CNC 机床运动的原理非常简单，程序员只需编写一组说明让机床如何运动的指令，并将程序输入机床计算机中，计算机阅读指令并向电机发出信号，使电机驱动机床工作台移动便可加工零件。这些指令均以地址字的格式来编写，每个信息或数据都是以数值字与地址符的形式输入计算机，并且地址字符以英文字母的形式写在数值字的前面。例如，N105 表示 N 是数字信息 105 的地址。因此控制器能够简易快捷地处理以这种形式输入的所有数据。一组典型的地址字形式如下所示：

N115 S1500 G81 X120 Y55.0 Z－12.0 R2.0 F150 M3 T0101

它主要包含六项功能。

1. 坐标功能

用刀尖点坐标值编程是为了加工出给定零件的几何尺寸。坐标值通过使用地址字符如 X、Y、Z、U、V、W、I、J、K 等确定。所有的这些地址字符通常和小数点一同标记，而小数点位数取决于机床的分辨率(对于精密数控机床，其分辨率至少是 1μm 或更少)。

例如：X120.505　　Y－55.3　　Z－12.0

2. 进给功能

一般来说，进给功能地址字符用 F 表示，并以速度为单位。例如，F150 表示进给速度为 150mm/min，这是刀具沿着编程轨迹实际运行的速度值，尽管取决于编程路径，但由控制器发出的实际进给依然存在一些偏差，控制器也对每个轴的实际进给速度进行计算。

3. 转速功能

转速可直接由每分钟的转数来设定，地址字符用 S 来表示。如 S1500 表示主轴转速设为 1500r/min。

4. 刀具功能

刀具功能通常由地址字符 P 来表示，根据刀具库容量，地址字符 P 含有两位或更多位数字。一般来说是两位，如 P15 这个指令会将刀库中位置编号为 15 或者刀具编号为 15 的刀具安装在主轴上，代替主轴上原有的刀具。而从主轴上替换下来的刀具，则被送回至 15 号刀具所在的空位处。

刀具偏置用地址字符 T 来编程，如 T1513 表示刀具号 15(即位于刀库中 15 号刀座)的刀具将被装在主轴上，并且当刀具加工时，将会执行偏置寄存器 13 号地址中存入的数值。

5. 准备功能

准备功能由地址字符 G 来表示，这种准备功能与机床各轴的运动以及相关的几何形状有关。它含有两位数字，如 G01，G42，G90，而这些都作为国际标准化组织的规格。然而，如今控制器将位数增加到了 3 位或 4 位。

6. 辅助功能

实际上，辅助功能可以对机床实行某些控制，因而影响机床的运行。一般来说每一组程序段中只允许有一个 M 代码。然而一些控制器允许两个或更多 M 代码在一个程序段中出现。但前提是这些 M 代码不能相互排斥。例如，切削液开(M07)和关(M09)不能同时出现在同一组程序段中。

经国际标准化组织标准化了的 M 代码的数量，比直接控制机床上的操作的 G 代码要少一些。

7. 程序号

在许多数控系统中规定要对一个程序的开头做出相应的标记，以便于搜索已存储的程序，法那克控制系统中，用符号“O”或“：”来标记程序号，符号的后面是数字。例如：O238 或：238，这个信息不会与数控程序相干扰。

Unit 6

Text 6: Balancing

Introduction

Any link or member that is in pure rotation can, theoretically, be perfectly balanced to eliminate all shaking forces and shaking moments. It is accepted design practice to balance all rotating members in a machine unless shaking forces are desired (as in a vibrating shaker mechanism, for example)[2]. A rotating member can be balanced either statically or dynamically. Static balance is a subset of dynamic balance. To achieve complete balance requires that dynamic balancing be done[3]. In some cases, static balancing can be an acceptable substitute for dynamic balancing and is generally easier to do[4].

Rotating parts can, and generally should, be designed to be inherently balanced by their geometry. However, the vagaries of production tolerances guarantee that there will still be some small unbalance in each part[5]. Thus a balancing procedure will have to be applied to each part after manufacture. The amount and location of any imbalance can be measured quite accurately and compensated for by adding or removing material in the correct locations[6].

In this chapter we will investigate the mathematics of determining and designing a state of static and dynamic balance in rotating elements and also in mechanisms having complex motion, such as the four-bar linkage. The methods and equipment used to measure and correct imbalance in manufactured assemblies will also be discussed. It is quite convenient to use the method of d'Alembert, when discussing rotating imbalance, applying inertia forces to the rotating elements, so we will do that.

Static Balance

Despite its name, static balance does apply to things in motion. The unbalanced forces of concern are due to the accelerations of masses in the system. The requirement for static balance is simply that the sum of all forces on the moving system (including d'Alembert inertial forces) must be zero.

$$\sum \boldsymbol{F} - m\boldsymbol{a} = 0 \tag{6.1}$$

This, of course, is simply a restatement of Newton's law. Another name for static balance is single-plane balance, which means that the masses which are generating the inertia forces are in, or nearly in, the same plane[7]. It is essentially a two-dimensional problem. Some examples of common devices which meet this criterion, and thus can successfully be statically balanced, are: a single gear or pulley on a shaft, a bicycle or motorcycle tire and wheel, a thin flywheel, an airplane propeller, an individual turbine blade-wheel(but not the entire turbine). The common denominator among these devices is that they are all short in the axial direction compared to the radial direction, and thus can be considered to exist in a single plane. An automobile tire and wheel is only marginally suited to static balancing as it is reasonably thick in the axial direction compared to its diameter. Despite this fact, auto tires are sometimes statically balanced. More often they are dynamically balanced and will be discussed under that topic.

Dynamic Balance

Dynamic balance is sometimes called two-plane balance. It requires that two criteria be met. The sum of the forces must be zero(static balance) plus the sum of the moments must also be zero[8].

$$\sum \boldsymbol{F} = 0$$
$$\sum \boldsymbol{M} = 0 \tag{6.2}$$

Some examples of devices which require dynamic balancing are: rollers, crank-shafts. The common denominator among these devices is that their mass may be unevenly distributed both rotationally around their axis and longitudinally along their axis.

It is always good practice to first statically balance all individual components that go into an assembly, if possible. This will reduce the amount of dynamic imbalance that must be corrected in the final assembly and also reduce the bending moment on the shaft. A common example of this situation is the aircraft turbine which consists of a number of circular turbine wheels arranged along a shaft. Since these spin at high speed, the inertia forces due to any imbalance can be very large. The individual wheels are statically balanced before being assembled to the shaft. The final assembly is then dynamically balanced.

Words and Expressions

1. shaker ['ʃeikə] *n.* ① 振荡器，振动筛 ② 激励者，引导者
2. vagary ['veigəri:] *n.* ① 难以预测的变化 ② 奇想，异想天开
3. tolerance ['tələrəns] *n.* ① 偏差，公差，容限 ② 耐力，耐量
4. compensate ['kəmpenseit] *v.* ① 平衡，校正 ② 补偿，赔偿，抵消
5. linkage ['liŋkidʒ] *n.* ① 联动装置，链系 ② 连接，联动

6. inertia [i'nə:ʃjə] *n.* ①惯性，惯量 ② 惰性，迟钝
7. Method of d'Alembert 达朗贝尔原理
8. mass [mæs] *n.* ① 质量 ② 团，块，堆
9. pulley ['puli:] *n.* 滑轮，滑轮组，皮带轮
10. shaft [ʃa:ft] *n.* ① 轴，传动轴 ② 杆状物
11. flywheel ['flaiwi:l] *n.* ① 飞轮，惯性轮
12. propeller [prə'pelə] *n.* ① (飞机等的)螺旋桨，推进器 ② 推进者，推动者
    propeller shaft 螺(旋)桨轴
13. turbine ['tə:bin] *n.* 涡轮机，叶轮机，透平机
14. blade-wheel [bleid'hwi:l] *n.* 装有叶片的叶轮
15. denominator [di'nəmə'neitə] *n.* ① 共同特性，共同特色 ② 标准，衡量的尺度，一般水准
16. axial ['æksi:əl] *n.* ① 轴向的 ② 轴的，成轴的
17. moment ['məumənt] *n.* ① 矩，力矩 ② 动差
18. roller ['rəulə] *n.* ① 轧辊 ② 完成旋转轧制成形的主要工具
19. crankshaft [kræŋk'ʃa:ft] *n.* 曲轴

Notes

1. 本篇课文语法现象重点：①被动语态在科技文章中的应用。科技文章以描述或陈述事实为主，强调客观性、真理性及精确性，因此在语言表达上需避免使用体现主观意愿的主动语态，而更多地使用被动语态，从而使文体更加正式，表达也更具说服力。②并列句中省略现象。并列句中，当从句主语(或主语+谓语)与主句主语(主语+谓语)一致时，从句中与主句相同的部分可省略。

2. It is accepted design practice to balance all rotating members in a machine unless shaking forces are desired(as in a vibrating shaker mechanism, for example).

本句为典型的科技文章写作句式。主句基本框架 it is+adj/n. +to do sth 中，it 为形式主语，不定式部分 to balance all rotating members in a machine 为真正主语。这种句式有效地避免了英语表达中忌讳的“头重脚轻”，使得阅读更为省力，表达更为地道。翻译时，多将原文中的真正主语译为译文中的主语。此外，本句还包含一个 unless 引导的条件状语从句。本句可译为：除非要求存在振动力，否则使机器内部各旋转组件运转平衡的设计最为常见。(如：振动筛的构造原理)。

3. To achieve complete balance requires that dynamic balancing be done.

从结构上看，本句很简单。主语为不定式短语 To achieve complete balance，谓语动词 require，后接 that 引导的宾语从句。但值得注意的是：宾语从句的谓语动词是动词原形 be 而非第三人称单数 is，这便涉及英语中一个重要的语法现象——虚拟语气。英语中，表示请求、建议、命令的一些动词，如：require，demand，decide，insist，order，

propose，recommend，request，suggest，vote 等后接 that 引导的宾语从句时，谓语动词要用 should +V，should 可以省略。本句可译为：要达到完全平衡，就必须实现动态平衡。

4. In some cases，static balancing can be an acceptable substitute for dynamic balancing and is generally easier to do.

本句为连词 and 连接的并列句，二者虽为并列关系，但后一分句对前一分句有很强的依赖性。首先，由于前后两分句主语相同，因此后一分句省略主语 static balancing；其次，后一分句要根据前一分句的表达才可明确比较级 easier 所比较的双方为 static balancing 与 dynamic balancing。本句中短语 an substitute for 意为"作为…的替代品"。本句可译为：在某些情况下，静态平衡可以替代动态平衡，比较而言静态平衡更容易实现。

5. However，the vagaries of production tolerances guarantee that there will still be some small unbalance in each part.

本句中 guarantee 并不表示"担保、确保、保证"等积极词义，而是"肯定…必然发生"之意，用作此意时，后常接 that 引导的从句做宾语。此句中 unbalance 为名词，词义等同于 imbalance，意为"不平衡，非平衡"。本句可译为：然而，生产公差数值的不确定性导致运转中的各部件仍存在一些小的"不平衡"。

6. The amount and location of any imbalance can be measured quite accurately and compensated for by adding or removing material in the correct locations.

本句仍为 and 引导的并列句，前后分句均为被动语态。后一分句省略了与前一分句相同的主语+谓语 The amount and location of any imbalance can be；此外，后一分句中出现 for 与 by 两介词连用，其中介词 for 与动词 compensate 构成固定短语，意为"补偿"，不可省；而介词 by 引导方式状语，与 for 不发生关系。本句可译为：无论是数量还是位置上的不平衡都可以准确地测量出来，并通过在适当的位置附加或去掉一些质量加以弥补和改进。

7. Another name for static balance is single - plane balance，which means that the masses which are generating the inertia forces are in，or nearly in，the same plane.

本句为复杂复句。全句的主语为 Another name for static balance，single - plane balance 既作为主句的表语，也是 which 引导的定语从句的先行词，该定语从句至全句末(the same plane)结束；该定语从句中又包含一个 that 引导的宾语从句，宾语从句的主语为 the masses，整个宾语从句至全句末(the same plane)结束；the masses 同时作为另一 which 引导的定语从句的先行词，该从句全句为 which are generating the inertia forces。全句可译为：静态平衡还可以叫做单面平衡，这意味着，产生惯性力的质量在或几乎在同一个面上。

8. The sum of the forces must be zero(static balance) plus the sum of the moments must also be zero.

本句为由连词 plus 连接的并列句，此处 plus 的作用及含义等同于常用并列连词 and；前后两分句使用完全相同的句式结构，旨在强调二者同等重要，不分伯仲。本句可译为：力的总和必须为零(静态平衡)，且力矩的总和也必须为零。

Word-Study

Balance, Balanced, Imbalance, Unbalance, Unbalanced

balance n. a situation in which different aspects or features are treated equally or exist in the correct relationship to each other.

v. to create or preserve a good or correct balance between different features or aspects.

balanced: a. with all parts combining well together or existing in the correct amount

imbalance n. a situation in which the balance between things is not equal or fair

unbalance v. to make something no longer balanced, for example by giving too much importance to one part of it.

n. lacking of balance.

unbalanced a. (usually before noun) lacking balance or giving too much or too little importance to one part or aspect of something.

Sentence Patterns

Verb + that + (should) + do

e. g. To achieve complete balance *requires that* dynamic balancing(*should*)*be* done.

It *requires that* two criteria(*should*)*be* met.

decide/demand/require/suggest insist/move/order/prefer/vote/advise/ propose/recommend/request	that	(should)+do

Exercises

Ⅰ. Give brief answers to the following questions.

1. What's the relationship between static balance and dynamic balance?
2. Which kind of balance is easier to achieve, static balance or dynamic balance?
3. Why small unbalance can not be avoided in rotating parts?
4. What can be done to compensate for the amount and location of measured imbalance?
5. What are the requirements for static balance and dynamic balance respectively?
6. What's the common denominator among the devices which can be statically balanced?
7. What's the common denominator among the devices which require dynamic balancing?

Ⅱ. Decide the following sentences are true(T)or false(F)according to the passage.

1. Any link or member in pure rotation can be perfectly balanced. (　　)
2. Static balance can not only apply to things at rest, but also apply to things in motion. (　　)
3. An airplane propeller is a good example of dynamic balance. (　　)
4. Auto tires are always dynamically balanced. (　　)
5. The individual wheels of the aircraft turbine will not be dynamically balanced until being assembled to the shaft. (　　)

Ⅲ. Match the items listed in the following two columns.

Column A	Column B
1. (　)pulley	A) a metal bar in an engine that causes a part to move when another part moves
2. (　)inertia	B) a connection made between two or more things
3. (　)flywheel	C) a piece of equipment with blades that spin, used for moving a ship or aircraft
4. (　)tolerance	D) a piece of equipment used for lifting something very heavy
5. (　)linkage	E) an engine or a machine that uses the pressure of liquid or gas on a wheel to get power
6. (　)shaft	F) the force that makes an object stay in the same position until it is moved or continue moving until it is stopped
7. (　)turbine	G) a heavy wheel in a machine or engine that keeps it operating at a steady speed
8. (　)propeller	H) the amount by which the size of a part of a machine can be different from the standard size before it prevents the machine from operating correctly.

Ⅳ. Fill in the following blanks with words mentioned in Exercise III.

1. A ________ diet contains lots of fruit and green vegetables.
2. We have to ________ the needs and tastes of all our customers.
3. It can be hard to find the right ________ between advising your children and controlling them.
4. There is an increasing social ________ in recruitment to higher education.
5. A good journalist should try to avoid the ________ news coverage.

Ⅴ. Rewrite the following sentences using "*Verb*+*that*+(*should*)+*do*" pattern.

1. I suggested his finishing up that project quickly.
2. I demanded his accompanying me to the hearing.
3. She insists on his taking his vacation now.
4. I prefer Mary to type the letters.
5. He advised her to wait for a few weeks.
6. He ordered the troops to march to the front at once.

Reading 6: Fatigue Strength

In everyday life, materials are rarely subjected to a single force which does not change, i. e. a static load. Generally the load varies in magnitude. Each vehicle crossing a bridge sets up stresses in the structure(Fig. 6. 1). Aircraft cabins are pressurized in flight, creating tensile stresses in the fuselage skin which are released on return to sea level. The surfaces of the axle shaft of a railway carriage are alternately put in tension and compression as the wheel rotates(Fig. 6. 2).

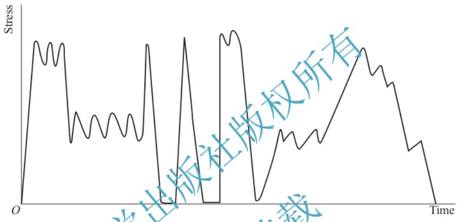


Fig. 6. 1 Variations in stress experienced by a bridge as vehicles cross it

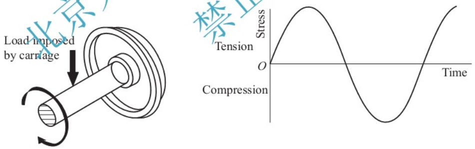


Fig. 6. 2 Alternate tension and compression in a railway axle

In each of the examples mentioned, failures have occurred in service in spite of the fact that the stresses involved were always below the elastic limit. Large cracks have been discovered in the steelwork of motorway bridges. The disastrous failures of the first jet airliners(the Comet) were associated with cracks formed at the corners of window openings. Railway axles have to be continually checked using ultrasonic flaw detection to monitor the onset of cracking.

The important point to note in each of these cases is that the stress levels were not constant or static. They fluctuated from zero to tensile, or from zero to compressive, or they alternated between tensile and compressive. Under such conditions of dynamic loading, fatigue cracks are propagated through the material, presenting a very real risk of total failure.

Three stages can be identified in a fatigue failure: firstly the initiation of the crack, then propagation, and finally complete fracture. Fatigue cracks start at the surface, and each application or change of load extends the crack by a small amount. As the crack grows, the amount of solid material left to carry the load decreases. The stress in this region increases until simple tensile or compressive failure occurs. The surface of the fracture clearly shows the smooth region of the fatigue crack and the coarser crystalline fracture (Fig6. 3). The origin of the crack can be identified, and the smooth region often contains semicircular markings(beach marks) which correspond to the stepwise progression of the fatigue crack.

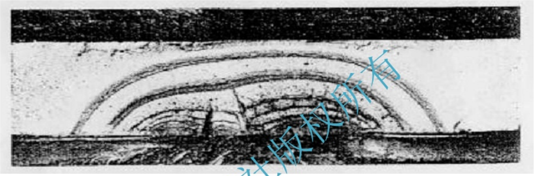


Fig. 6. 3 Fracture surface of a fatigue failure

Each discrete application of load constitutes one cycle. Fatigue life is measured not in terms of time but as the number of cycles that the material can accommodate before failure takes place. The fatigue life(N)is a function of the stress level(S), and the relationship is shown on a stress – life or $S-N$ curve(Fig. 6. 4). As there may be many millions of cycles, a log scale is used for the life(N).

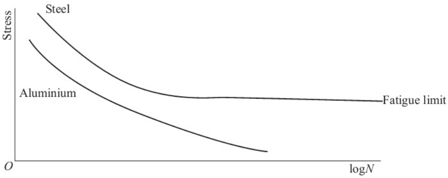


Fig. 6. 4 $S-N$ curves for steel and aluminum

Materials can be divided into two groups according to the shape of the $S-N$ curve. In both groups the life increases markedly as the stress is lowered. With materials such as steel, there is a stress level below which fatigue cracks are not initiated and the life is indefinite. By contrast, this fatigue limit is not found with aluminum alloys and thermosetting plastics, for which a definite life exists even at low stress levels.

The $S-N$ curve is also affected by the presence of notches. These concentrate the stresses at a point, so making it easier to initiate the fatigue crack(Fig. 6. 5). This effect

can be interpreted in two ways: either the life is shorter because fewer cycles are needed to start the crack, or the maximum stress for a given life is lower. Both sharp corners and deep scratches act as stress raisers, and great care must be exercised in the design and manufacture of components subjected to dynamic loading, to minimize the chance of initiating fatigue cracks.

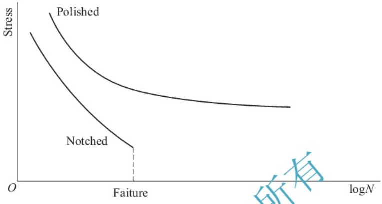


Fig. 6. 5 $S-N$ curves for polished and notched steel bars

What, then, is the fatigue strength of a material? As we have seen, some metals have a fatigue limit, but there is no unique value for fatigue strength. The answer must be related to service conditions and requirements. Once the designer has specified the desired life, the fatigue strength can be regarded as the highest stress which will give the required number of cycles.

参考译文:

Reading 6 疲 劳 强 度

日常生活中，材料很少会受到单一不变力的影响，即静载荷。通常，载荷随着大小的变化而变化。每辆经过桥面的车辆都会对桥产生应力(图 6.1)。飞机密封客舱在飞行中是受压的，这就导致飞机机身表面形成拉应力，该应力在飞机返回海平面的过程中会得到释放。火车车轮转动时，其客车车轴表面会交替处于拉深和压缩两种状态(图 6.2)。

尽管上述所有例子所涉及的应力总是低于弹性极限，但在运行过程中还是会出现故障，高速公路桥梁的钢结构已发现 3 大裂痕。第一架喷气式客机(彗星)灾难性的故障与窗角的裂缝密不可分。火车车轴则不得不采用超声波探测装置不断监视裂痕的产生。

上述案例中值得注意的重点是：应力水平并非恒久不变或是处于静止状态。它们要么是从零状态变化为拉深状态，要么是从零状态变化为压缩状态，还可能是从拉深状态变化为压缩状态。在动载荷情况下，疲劳裂纹通过材料扩展，面临彻底断裂的风险。

疲劳失效可分为三个阶段：首先是裂纹出现，然后是裂纹传播，最终是完全断裂。疲劳裂纹开始于表面，且每次施加或改变负荷都会使裂痕略微扩大。随着裂缝的扩大，剩余的可承受载荷的固体材料数量就会减少。这一区域内的压力会持续增加，直到出现彻底的

拉深断裂或压缩断裂。断口表面清晰地展现了疲劳裂纹光滑区域和较粗晶粒状断口面区域（图 6.3）。裂纹的起因可以确定，光滑区域常有些半圆形标记（海滩状标记），它们见证了疲劳裂纹逐步形成的事实。

每次载荷的不连续施加构成一个应力循环。疲劳寿命不是以时间，而是以故障发生前材料可承受的应力循环次数衡量。疲劳寿命（N）是应力水平（S）的函数，二者关系如应力寿命或 $S-N$ 曲线（图 6.4）所示。由于可能存在几百万次循环，所以需用对数值来记录疲劳寿命（N）。

根据 $S-N$ 曲线的形状，可将材料分为两类。这两类材料的疲劳寿命随着应力的减小而显著增加。由于钢这类材料有一个应力水平，低于它时，疲劳裂纹不会出现，且寿命尚不能确定。相比之下，铝合金和热固性塑料中不存在这种疲劳极限，对于这类材料，确切寿命甚至处于低应力水平。

$S-N$ 曲线也受到切口的影响。这些切口把压力集中在一点，因此更容易形成疲劳裂纹（图 6.5）。我们可以从两个方面来解释这种影响：一是由于形成裂纹需要的循环次数较少，所以寿命就较短；二是给定寿命对应的最大应力值更低了。尖角和深划痕两者都会增加应力，因此在动力载荷下，设计和制造机械部件时必须小心操作，降低出现疲劳裂纹的几率。

那么，什么是材料的疲劳强度？正如我们所见，有些金属有疲劳极限，但疲劳强度的值不是唯一的。答案须与工作条件和技术要求相联系。一旦设计师确定了期望寿命，疲劳强度则可被视为是满足所需循环次数的最大应力。

Unit 7

Text 7: Gears

Spur Gears

Spur gears are ones in which the teeth are parallel to the axis of the gear. This is the simplest and least expensive form of gear to make. Spur gears can only be meshed if their axes are parallel. Fig. 7. 1 shows parallel axis spur gears.

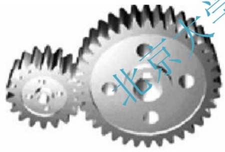
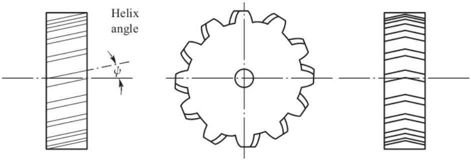


Fig. 7. 1 parallel axis spur gears

Helical Gears

Helical gears are ones in which the teeth are at a helix angle ψ with respect to the axis of the gear as shown in Fig. 7. 2(a). Fig. 7. 3 shows a pair of opposite-hand **helical gears** in mesh. Their axes are parallel. Two **crossed helical gears** of the same hand can be meshed with their axes at an angle as shown in Fig. 7. 4. The helix angles can be designed to accommodate any skew angle between the nonintersecting shafts.



(a) Helix angle (b) Herrigbone gear

Fig. 7. 2 A helical gear and a herringbone gear

Helical gears are more expensive than spur gears but offer some advantages. They run quieter than spur gears because of the smoother and more gradual contact between their

angled surfaces as the teeth come into mesh. Spur gear teeth mesh along their entire face width at once. The sudden impact of tooth on tooth causes vibrations which are heard as a "whine" which is characteristic of spur gears but is absent with helicals. Also, for the same gear diameter and diametral pitch, a helical gear is stronger due to the slightly thicker tooth form in a plane perpendicular to the axis of rotation.[1]

Fig. 7. 3 parallel axis helical gears

Fig. 7. 4 Crossed axis helical gears

Herringbone Gears

Herringbone gears are formed by joining two helical gears of identical pitch and diameter but of opposite hand on the same shaft. These two sets of teeth are often cut on the same gear blank. The advantage compared to a helical gear is the internal cancellation of its axial thrust loads since each "hand" half of the herringbone gear has an oppositely directed thrust load.[2] Thus *no* thrust bearings are needed *other than* to locate the shaft axially. This type of gear is much more expensive than a helical gear and tends to be used in large, high-power applications such as ship drives, where the frictional losses from axial loads would be prohibitive. A herringbone gear is shown in Fig. 7. 2(b). Its face view is the same as the helical gear's.

Worms and Worm Gears

If the helix angle is increased sufficiently, the result will be a worm, which has only one tooth wrapped continuously around its circumference a number of times, analogous to screw thread.[3] This worm can be meshed with a special **worm gear** (or **worm wheel**) whose axis is perpendicular to that of the worm as shown in Fig. 7. 5. Because the driving worm typically has only one tooth, the ratio of the gearset is equal to one over the number of teeth on the worm gear. These teeth are not involutes over their entire face which means that the center distance must be maintained accurately to guarantee conjugate action.

Fig. 7. 5 A worm and worm gear

Bevel Gears

For right-angle drives, crossed helical gears or a wormset can be used. For any angle between the shafts, including 90°, bevel gears may be the solution. Just as spur gears are based on rolling cylinders, **bevel gears** are based on rolling cones as shown in Fig. 7.6. The angle between the axes of the cones and the included angles of the cones can be any compatible values as long as the apices of the cones intersect. If they did not intersect, there would be a mismatch of velocity at the interface. The apex of each cone has zero radius, thus zero velocity. All other points on the cone surface will have nonzero velocity. The velocity ratio of the bevel gears is defined by equation:

$$m_V = \frac{\omega_{out}}{\omega_{in}} = \pm\frac{r_{in}}{r_{out}} = \pm\frac{d_{in}}{d_{out}}$$

using the pitch diameters at any common point of intersection of cone diameters.

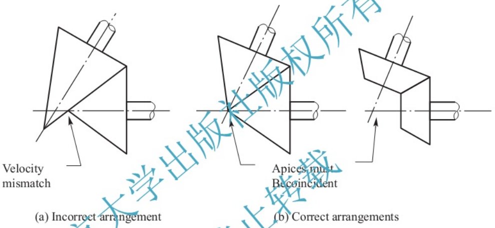


Fig. 7.6　Bevel gears are based on rolling cones

Words and Expressions

1. mesh　[meʃ]　*v.* 啮合
2. with respect to　关于，至于
3. crossed helical gear　① 交叉斜齿轮　② 交叉轴螺旋齿轮
4. accommodate　[ə'kɔmədeit]　*v.* ① 适应，调节　② 接纳，收容，容纳　③ 供应
5. skew angle　斜交角，相交角
6. nonintersecting shaft　非交叉轴
7. vibration　[vai'breiʃən]　*n.* 振动，颤动
8. diameter　[dai'æmitə]　*n.* 直径
9. diametral pitch　径节
10. identical　[ai'dentikəl]　*a.* 完全相同的，同一的
11. cancellation　[kænsə'leiʃən]　*n.* 抵消，取消，解除

12. axial thrust load 轴向推力载荷
13. frictional losses 摩擦损耗
14. conjugate action 共轭运动(作用)
15. circumference [sə'kʌmfərəns] *n.* ① 圆周，周线 ② 周界
16. analogous [ə'næləgəs] *a.* 类似的，相似的
17. screw thread 螺纹
18. ratio ['reiʃəu] *n.* ① 比，比率，比例，传动比 ② 系数，关系
19. compatible [kəm'pætəbl] *a.* ① 兼容的 ② 一致的
20. velocity [vi'lɔsiti] *n.* 速度，速率
21. interface ['intəfeis] *n.* 界面，分界面
22. rolling ['rəuliŋ] *n.* ① 滚动 ② 滚压，轧制，碾压
rolling cone 滚锥

Notes

1. Also, for the same gear diameter and diametral pitch, a helical gear is stronger due to the slightly thicker tooth form in a plane perpendicular to the axis of rotation.

从结构上看，本句是一个简单句，主干为：a helical gear is stronger，其中，also 置于句首，起强调作用，后面是由介词 for 引导的条件状语；due to 是介词短语，表示“由于”，在句中作原因状语；perpendicular to the axis of rotation 是形容词短语，作 plane 的后置定语。因此，本句可译为：同样，对于直径和径节均相同的齿轮，因斜齿轮在垂直于其旋转轴的平面内有较厚齿形而强度更高。

2. The advantage compared to a helical gear is the internal cancellation of its axial thrust loads since each “hand” half of the herringbone gear has an oppositely directed thrust load.

本句是一个由 since 引导的原因状语从句，主句部分为“The advantage compared to a helical gear is the internal cancellation of its axial thrust loads”，其中，由 compared to a helical gear 构成的过去分词短语作 advantage 的后置定语；since 在这里相当于 because，引导原因状语从句。因此，本句可译为：与斜齿轮相比，其优点是可消除齿轮内部轴向力，因为人字齿轮每半边齿存在一个方向相反的轴向推力载荷。

3. If the helix angle is increased sufficiently, the result will be a worm, which has only one tooth wrapped continuously around its circumference a number of times, analogous to screw thread.

本句是一个由 if 引导的条件状语从句；其中，主句中包含由 which 引导的非限定性定语从句，修饰先行词 worm。因此，本句可译为：如果螺旋角增加到足够大，将会形成蜗杆。蜗杆只有一个轮齿，并多次不间断地缠绕在蜗杆圆周上围，类似于螺纹。

Word-Study

Ⅰ. *conjugate*

① *adj*. 共轭的，相配的，对合的，配合的；

e. g. conjugate action 共轭作用

conjugate angle 共轭角

conjugate curve 共轭曲线

conjugate field 共轭域

conjugate planes 共轭平面

conjugate surface 共轭面

conjugate tooth 共轭轮齿

② *n*. 共轭值，成对物，合成物，轭合物，共轭物；

e. g. harmonic conjugates 调和共轭

conjugation *n*. 共轭(性)，接合，耦合，配对；

e. g. conjugation line 共轭线

conjugacy *n*. 共轭性

e. g. conjugacy of the second kind 第二类共轭性

Ⅱ. *mesh*

① *n*. & *v*. 啮合

e. g. The wheels meshed well. 机轮啮合良好。

be in mesh (齿轮)相互啮合

go into mesh with 与…… 相啮合

out of mesh (齿轮等)不相啮合

worm mesh 蜗杆啮合

② *n*. 网孔，网络，网状结构；v. 使成网状

e. g. mesh network 网状网络

mesh node 网孔节点

mesh coordinate 网格坐标

mesh filter 网式过滤器

meshing *n*. 啮合，衔接；

e. g. meshing bevel gear 啮合伞齿轮

meshing engagement 啮合

meshing gear 啮合齿轮

meshing point 啮合点

meshing with zero backlash 无侧隙啮合

meshing zone 啮合区

Ⅲ. *rolling*, *roller*

rolling

① *n*. 滚动；

e. g. rolling axis 滚动轴线

rolling bearing 滚动轴承

rolling body 滚动体

rolling cone 滚锥

rolling contact gears 滚动接触齿轮系

② *n*. 滚压，轧制，辊压；

e. g. rolling face 轧辊工作面

rolling defect 轧制缺陷

rolling metal 被轧制的金属，轧件

rolling mill 滚轧机，轧钢机

rolling mill assembly 轧机装置

rolling press 滚压机

roller *n*. 滚子，柱销套

e. g. roller bearing center 滚柱轴承中心

roller chain 滚子链

roller clutch 滚柱离合器

roller bearing steel 滚柱轴承钢

roller cam 滚子凸轮

Ⅳ. *involute*

① *n*. 渐开线，切展线；

e. g. involute gear 渐开线齿轮

involute gear cutter 渐开线齿轮铣刀

involute gear hob 渐开线齿轮滚刀

involute profile 渐开线齿廓，渐开线齿形

involute tooth 渐开线轮齿

involute rack 渐开线齿条

② *a*. 内旋的，内卷的；

e. g. involute blade 内旋调制叶片

involute reticle blade 内旋调制盘叶片

Sentence Patterns

Ⅰ. no other than

1. 除 . . . 之外，只有　　2. 正是，就是

【例句】

He has no friend other than you.　　他除你之外就没有其他朋友了。

It was no other than the king.　　那不是别人，是国王本人。

He resigned for no other reason than this. 他辞职不外是为了这个理由。

Ⅱ. with respect to

(refers to about, with regards to 关于，至于，就…而言)

With respect to
1. analogue data, we need to place it in digital form.
2. data, we should change its form or location.
3. data in main storage, we should copy it to backing storage.
4. salary, I expect around 7, 500 yuan per month.
5. your requests, we regret that we are unable to assist you in this matter.
6. a unit of hardware or software, we adapt it to meet the needs of a particular user.
7. their future plans, we're still unsettled.

Ⅲ. analogous to

类似，类似于

1. It seems that this device is analogous to that one, but they are quite different.

2. All radiant energy has wavelike characteristics, analogous to those of waves that move through water.

3. In physics, conservation laws are analogous to linguistic rules.

4. This classification is called the parity of the permutation analogous to the definition of parity of integers.

5. The image of seismic discontinuous points is analogous to CMP stacking technique in reflection wave exploration.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What are Spur Gears?
2. What are the advantages of the helical gears?
3. Compared to a helical gear, what's the advantage of herringbone gears?
4. What is the ratio of the gearset?
5. On what are bevel gears based?

Ⅱ. Match the items listed in the following two columns.

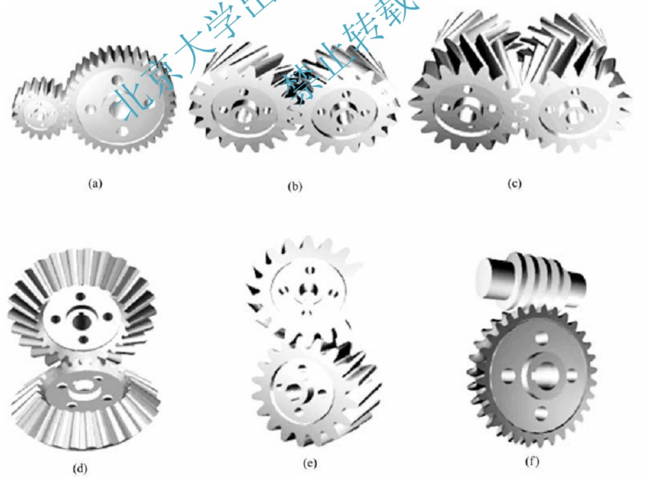
Column A	Column B
1. ( )crossed helical gear	A) 轴向推力负荷
2. ( )axial thrust load	B) 摩擦损耗
3. ( )screw thread	C) 径节
4. ( )frictional losses	D) 交叉斜齿轮
5. ( )diametral pitch	E) 螺纹

Ⅲ. Fill in the blanks with the words given below. Change the form where necessary.

accommodate	perpendicular	identical	cancellation	compatible
analogous	mesh	with respect to	vibration	no other than

1. The water molecules in a glass of water are ________ .
2. All equipment chosen and all design procedures must be ________ with each other.
3. Her ________ of her trip to Paris upset our plan.
4. CBQ is a public domain networking technique that can ________ all network speeds.
5. Make sure to cut pipe keeping the cut plane ________ to the axle.
6. The wheels ________ well.
7. ________ frequency ________ the driving frequency will satisfy the equation of motion.
8. Even at full speedthe ship's engines cause very little ________ .
9. It seems that this device is ________ to that one, but they are quite different.
10. It's going to raise a lot of problems ________ atmosphere pollution.

Ⅳ. Choose the right name for the following pictures and point out the structure and application characteristics of them.



Reading 7: Simple Gear Trains

A gear train is any collection of two or more meshing gears. A simple gear train is one in which each shaft carries only one gear, the most basic, two-gear example of which is shown in Fig. 7. 7.

The *velocity ratio* (sometimes called *train ratio*) of this gearset is found by expanding equation:

$$m_V = \pm \frac{d_{in}}{d_{out}} = \pm \frac{N_{in}}{N_{out}} \tag{7.1}$$

Fig. 7. 8 shows a simple gear train with five gears in series. The expression for this simple train's velocity ratio is:

$$m_V = \left(-\frac{N_2}{N_3}\right)\left(-\frac{N_3}{N_4}\right)\left(-\frac{N_4}{N_5}\right)\left(-\frac{N_5}{N_6}\right) = +\frac{N_2}{N_6} \tag{7.2}$$

or in general terms:

$$m_V = \pm \frac{N_{in}}{N_{out}}$$

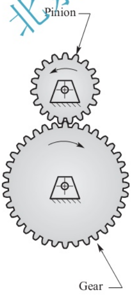


Fig. 7. 7 An external gearset

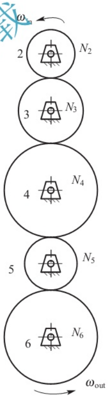


Fig. 7. 8 A simple gear train

which is the same as equation 7. 1 for a single gearset.

Each gearset potentially contributes to the overall train ratio, but in any case of a simple (series) train, the numerical effects of all gears except the first and last cancel out. The train ratio of a simple train is always just the ratio of the first gear over the last. Only the

sign of the overall ratio is affected by the intermediate gears which are called *idlers* because typically no power is taken from their shafts. If all gears in the train are external and there is an even number of gears in the train, the output direction will be opposite that of the input. If there is an odd number of external gears in the train, the output will be in the same direction as the input. Thus a single, external idler gear of any diameter can be used to change the direction of the output gear without affecting its velocity.

A single gearset of spur, helical, or bevel gears is usually limited to a ratio of about 10 : 1 simply because the gearset will become very large, expensive, and hard to package above that ratio if the pinion is kept above the minimum numbers of teeth shown in Table7. 1. If the need is to get a larger train ratio than can be obtained with a single gearset, it is clear from equation $m_p = \frac{Z}{P_b}$ (7. 3) that the simple train will be of no help.

Table 7. 1 Minimum Number of Pinion Teeth
To Avoid Interference Between a Full - Depth Pinion and a Full - Depth Rack

Pressure Angle(°)	Minimum Number of Teeth
14. 5	32
20	18
25	12

It is common practice to insert a single idler gear to change direction, but more than one idler is superfluous. There is little justification for designing a gear train as is shown in Fig. 7. 8. If the need is to connect two shafts that are far apart, a simple train of many gears could be used but will be more expensive than a chain or belt drive for the same application. Most gears are not cheap.

Compound Gear Trains

To get a train ratio of greater than about 10 : 1 with spur, helical, or bevel gears(or any combination thereof) it is necessary to **compound the train**(unless an epicyclic train is used). A compound train is one in which at least one shaft carries more than one gear. This will be a parallel or series - parallel arrangement, rather than the pure series connections of the simple gear train. Fig. 7. 9 shows a compound train of four gears, two of which, gears 3 and 4, are fixed on the same shaft and thus have the same angular velocity.

The train ratio is now:

$$m_V = \left(-\frac{N_2}{N_3}\right)\left(-\frac{N_4}{N_5}\right) \tag{7. 4a}$$

This can be generalized for any number of gears in the train as:

$$m_V = \pm\frac{\text{product of number of teeth on driver gears}}{\text{product of number of teeth on driven gears}} \tag{7. 4b}$$

Note that these intermediate ratios do not cancel and the overall train ratio is the product of the ratios of parallel gearsets. Thus a larger ratio can be obtained in a compound gear train despite the approximately 10 : 1 limitation on individual gearset ratios. The plus or

minus sign in equation (7.4b) depends on the number and type of meshes in the train, whether external or internal. Writing the expression in the form of equation (7.4a) and carefully noting the sign of each mesh ratio in the expression will result in the correct algebraic sign for the overall train ratio.

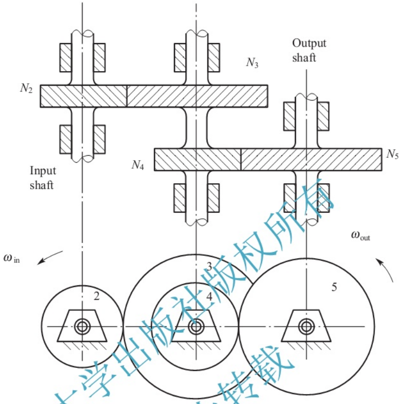


Fig. 7.9 A compound gear train

参考译文:

Reading 7 简单的齿轮系

齿轮系是两个或多个啮合齿轮的任意集合。一个简单的齿轮系是指每个轴上只安装一个齿轮的轮系。最基本的是如图 7.7 所示的由两个齿轮构成一个齿轮系。此类齿轮组的速度比(有时也称轮系传动比)由扩展方程式 $m_V=\pm\frac{d_{in}}{d_{out}}=\pm\frac{N_m}{N_{out}}$ (7.1)求得。图 7.8 显示了由串联 5 个齿轮组成的一个简单的齿轮系。这一简单齿轮系的传动比表达式如下:

$$m_V=\left(-\frac{N_2}{N_3}\right)\left(-\frac{N_3}{N_4}\right)\left(-\frac{N_4}{N_5}\right)\left(-\frac{N_5}{N_6}\right)=+\frac{N_2}{N_6} \tag{7.2}$$

通用表达式:

$$m_V=\pm\frac{N_{in}}{N_{out}}$$

对于单一齿轮组，此方程式与方程式(7.1)相同。

每个齿轮组都可能影响整个轮系的传动比，但在一个简单(串联)轮系的任何一种情况

下，除第一个和最后一个，所有齿轮的数值结果全部抵消。一个简单轮系的传动比通常是第一个齿轮与最后一个齿轮之比。只有总比率的符号会受到中间齿轮的影响。这些中间齿轮被称为惰轮，因为通常没有能量从它们的齿轮轴输出。如果轮系的所有齿轮都是外齿轮并且轮系中的齿轮数是偶数，输出端方向将与输入端方向相反；如果轮系中有奇数个外齿轮，那么输出端方向与输入端方向相同。因此，任意直径的单个、外齿的惰轮都可以在不影响速率的情况下改变输出端齿轮的转向。

无论是正齿轮、斜齿轮还是锥齿轮的单一齿轮组，其传动比通常限于 10∶1 的范围内，这主要因为如果小齿轮超过了表 7.1 所示的最少齿数，齿轮组达到这一传动比时，尺寸会变得非常大，成本增加且难以安装。与单一齿轮组所能获得的传动比相比，如果需要一个更大的轮系传动率，通过方程式 $m_{\mathrm{p}}=\dfrac{Z}{P_{\mathrm{b}}}$ (7.3)，可以清楚地看到，简单的齿轮系将于事无补。

通常，人们会插入一个惰轮来改变方向，但多于一个惰轮就未免多余了。设计一个如图 7.8 所示的齿轮系没有任何的合理性。如果需要连接两个离得较远的轴，那么由多个齿轮组成的一个简单的轮系便可以使用，但造价要比链传动或带传动高，大多数的齿轮都不便宜。

复合齿轮系(混合轮系)

为了通过直齿轮、斜齿轮或锥齿轮(或其任何组合)获得比 10∶1 更大的轮系传动比，复合齿轮系是十分必要的(周转轮系的使用除外)。复合齿轮系，即一个轴上至少安装一个以上齿轮。齿轮成并联或串并联排列，而不单纯是简单齿轮系的串联连接。图 7.9 显示了由四个齿轮组成的复合齿轮系。其中，齿轮 3 和齿轮 4 两个齿轮被固定在同一轴上，因此有相同的角速度。

轮系传动比为

$$m_{\mathrm{V}}=\left(-\frac{N_2}{N_3}\right)\left(-\frac{N_4}{N_5}\right) \tag{7.4a}$$

这一求解公式可推广到齿轮数为任意数量的轮系：

$$m_{\mathrm{V}}=\pm\frac{\text{从动轮齿数的连乘积}}{\text{主动轮齿数的连乘积}} \tag{7.4b}$$

要注意的是，这些中间传动比并没有抵消，并且整个齿轮系的传动率是并联齿轮组传动比的乘积。因此，尽管单个齿轮组传动比大约限制在 10∶1，但在复合齿轮系中可以得到更大的传动率。方程式(7.4b)中的加减号取决于轮系中齿轮啮合的数量和类型(无论是外啮合还是内啮合)。以方程式(7.4a)的形式写下的表达式应十分注意表达式中每个啮合传动比的符号，因为这将影响整个齿轮系传动比数学符号的正确性。

Unit 8

Text 8: Lubrication of Bearings

The machine tools in a workshop sometimes have their own electric motors, or they may take the power they need from a motor which feeds several machines[3]. The shafts which carry the power from the motor to the machines need some kind of support to keep them steady. We call these supports bearings. There are different types of bearings for different purposes. We can classify them according to whether they take the load on the shaft or the thrust along the axis of the shaft[4]. The former type is known as a journal bearing, and the latter type as a thrust bearing[5].

The rotating shaft bears on a stationary bush or tube: we therefore have two metal surfaces in close contact with each other, and sliding over each other often at high speed. This will cause friction and the bearing will become heated. So, have to protect the metal surfaces from overheating and damage[6]. First of all, we avoid making the shaft and the bush of the same material[7]. The shafting itself is generally of steel, but we use another metal such as cast-iron or bronze or white metal for the bush. At a certain temperature, the metal in the bush will seize or run, and this will prevent damage to the shaft. But of course it will not prevent overheating from occurring.

However, we can reduce the danger of overheating by lubrication. We have a thin film of oil between the two metallic surfaces to keep them apart. The internal friction of oil is much less than the friction between two solids, and generates less heat. Lubrication also offers another advantage. A film of oil on the metal surfaces will prevent them from corroding by protecting them from the air[8].

The sort of lubricant which we use depends largely on the running speed of the bearing. We can use grease in low-speed bearings, but grease offers more resistance to the turning movement of the shaft. Lighter oil causes less friction, and so an oily lubricant is better for high-speed bearings. The rotation of the shaft carries the film of oil round the inside of the bearing and keeps the shaft from contact with the bush which houses it[9]. We

can feed the oil into the bearing in - several ways. Sometimes we allow it to drip down under the influence of gravity. More commonly, a pump or gun feeds it in under pressure. In motor - car and other engines we half cover the bearing in an oil - bath, and oil splashes up into it.

We can reduce the amount of friction even more with rolling bearings. The hardened steel balls in this type of bearing roll round in a finely - ground ball race, and make little more than point contact with the race[10].

Words and Expressions

1. lubrication [lu:bri'keiʃən]	*n.* ①润滑(作用)②注油
2. lubricant ['lu:brikənt]	*n.* ①润滑剂，润滑油 ②促使减少摩擦的因素
3. feed [fi:d]	*v.* ①供/输(给、应、水、电)，喂 ②走入(量)
4. thrust [θrʌst]	*v* ①挤(入)，塞(入)②刺，戳 *n.* ①推力，驱动力，轴向(压力) ②猛推，刺，戳；
thrust bearing	推力轴承
5. journal ['dʒə:nl]	*n* ①(端、止推)轴颈 ②杂志，期刊
journal bearing	轴颈轴承
6. bear [bεə]	*v.* ①负担，承(经、忍)受，经得起 ②(负、带、含)有 ③给出，产生，推动 n. ①打孔器，小型冲(孔)机 ②熊
7. bearing ['bεəriŋ]	*n.* ①轴承(座)②支撑(座、架、点、面)
8. stationary ['steiʃənəri]	*a.* 不动(变)的，静止(态)的，固定的
9. bush [buʃ]	*n.* 衬套(瓦、管)，轴衬(瓦)，套管
10. tube [tju:b]	*n.* ①(轴)套 ②管子，软管 ③电子管，真空管
11. slide [slaid]	*n* ①滑(动、面)，滑动装置 ②滑板(阀)，导板 ③(显微镜)载片 *v.* 使滑(过、入、动)
12. overheat [əuvə'hi:t]	*v.* ①把... 加热过度，使太热 ②使过于热烈，使十分愤怒(或激动)
13. white metal	(银白色、低熔点的)白色金属 (如轴承合金)巴士合金
14. seize [si:z]	*v.* ①(机器等)卡(挤、咬)住

②扯裂、擦伤、磨损
③黏附(结)

15. run [rʌn] *v.* ①浇铸，熔铸 ②(固体融化)流动
③运行，经营

16. shafting ['ʃɑ:ftiŋ] *n.* ①轴系，制轴材料 ②(总称)轴

17. cast－iron 铸铁

18. corrode [kə'rəud] *v.* ①(使)腐蚀、使受损伤
②(渐渐)损害，损伤

19. corrodent [kə'rəudənt] *a.* 腐蚀(性)的
n. 腐蚀剂

20. grease [gri:s] *n.* ①润滑脂(膏)，油膏，黄油
②动物油脂

21. oily ['ɔili] *a.* ①(含、多)油的
②涂有油的，加油润滑的
③油滑的，谄媚的

22. house [haus] *v.* ①给……装外罩，遮盖
②安放，安置

23. finely－ground 磨得很细的

24. race [reis] *n.* ①(滚动轴承的)座圈，滚道，轮槽
②竞赛，航线，路(航、行)程

Notes

1. 本篇课文涉及机械设计基础中的轴承及其润滑的基础内容。题目：轴承的润滑。

2. 本篇课文语法现象的重点：①can、may 两情态动词在科技文章中的用法。在肯定陈述句中，用 can 表示“可能”与用“may”表示可能往往产生含义上的微妙差别。may 表示事实上的“可能性”；而 can 往往指逻辑上的“可能性”；但本文中 can 仅表示“能力”，相当于 be able to。②定语从句的用法。当用来修饰名词的定语过长，用一个或几个词表达不够明确时，我们可以用定语从句。定语从句分为限定性定语从句和非限定性定语从句，本篇课文中仅讨论限定性定语从句。

3. The machine tools in a workshop sometimes have their own electric motors, or they may take the power they need from a motor which feeds several machines. 本句是一个由连词 or 连接的并列句，第二分句中又包含两个定语从句：一个是 the power 作为先行词，后接省略引导词的从句 they need；另一个是由 which 引导的定语从句用来修饰先行词 a motor。本句可译为：车间里的车床要么有各自独立的电机，要么是一台电机同时为几部机器提供动力。

4. We can classify them according to whether they take the load on the shaft or the thrust along the axis of the shaft. 本句为简单复句。whether 引导的名词性从句做 according to 的介词宾语。并列连词 or 连接的并列成分为 the load on the shaft or the thrust

along the axis of the shaft。本句可译为：我们根据轴承承受的是传动轴上的负荷还是沿传动轴轴线方向的推力负荷对其进行分类。

5. The former type is known as a journal bearing, and the latter type as a thrust bearing. 本句为由连词 and 连接的并列复合句。the former... the latter... 结构的含义为前者... 后者...，本句中 the latter 后省略了与前一分句相同谓语 “is known”。本句可译为：前者称为轴颈轴承，后者称为推力轴承。

6. So, have to protect the metal surfaces from overheating and damage. 本句为祈使句。祈使加重了表达的语气，同时强调了这么做的必要性。本句可译为：于是防止金属表面过热和受损是必要的。

7. First of all, we avoid making the shaft and the bush of the same material. 本句中一个重点词汇的用法 avoid＋doing，意为 “避免(做)...”；the bush of the same material 中的 of 与文中下句用法相同，均表示 “由 ... 制成(组成)” 之意。本句可改写为我们常见的表达方式：we avoid the shaft and the bush being made of the same material. 本句可译为：首先，避免轴和轴衬的材质相同。

8. A film of oil on the metal surfaces will prevent them from corroding by protecting them from the air. 本句为简单句，但因有 by 引导的方式状语而略显复杂。句中短语 prevent...from 的用法与下文中 protect...from 及 keep...from 类似，意思是 from 的 “去除、免掉、排斥、剥夺” 加上动词本身的含义。本句可译为：润滑的另一个作用是通过金属表面的油膜来隔绝空气使其免遭腐蚀。

9. The rotation of the shaft carries the film of oil round the inside of the bearing and keeps the shaft from contact with the bush which houses it. 本句为由连词 and 连接的并列句，后一分句中的 which houses it 为定语从句，用来修饰先行词 the bush，it 指代之前的 the shaft. 本句可译为：转轴通过转动将轴承内部涂上油膜，从而将转轴与其轴衬隔开。

10. The hardened steel balls in this type of bearing roll round in a finely-ground ball race, and make little more than point contact with the race. 该句为并列句。短语 little more than 此处并不表示比较，而是固定短语，意为 “仅仅，只是 ... 而已”。本句可译为：这类轴承里的硬化钢珠在精致的滚珠轴承座圈内滚动，而其与座圈仅仅是点接触。

Sentence Patterns

Ⅰ. protect＋objective＋from＋noun

The new measures are designed to		public		people like these.
The turtles' shells		them		harm.
They huddled together to	protect	themselves	from	the wind.
The hat could only partially		his face		the sun
The shelters could		the injured		the rain.

Ⅱ. prevent sb/sth from doing

<table>
<tr><td>They took actions to</td><td rowspan="5">prevent</td><td>the disease</td><td rowspan="5">from</td><td>spreading.</td></tr>
<tr><td>Nothing will</td><td>us</td><td>going.</td></tr>
<tr><td>Rubber seals are fitted to</td><td>the gas</td><td>escaping.</td></tr>
<tr><td>This drug will</td><td>you</td><td>catching cold.</td></tr>
<tr><td>The law will</td><td>the owner</td><td>making any major changes.</td></tr>
</table>

Exercises

Ⅰ. Give brief answers to the following questions.

1. What's the relationship between shafts and bearings?
2. How could we classify bearings?
3. How could we protect the metal surfaces from overheating and damage?
4. What metals are commonly used to make the bush?
5. How could the metal in the bush prevent damage to the shaft?
6. What are the advantages of lubrication?
7. What kind of lubricant is better for high-speed bearings and low-speed bearings respectively?
8. Please state three ways to feed the oil into the bearings.

Ⅱ. Decide the following sentences are true(T) or false(F) according to the passage.

1. Journal bearings are those which take the load on the shaft. (　　)
2. Sometimes the rotating shaft has a bush or tube which houses it. (　　)
3. The metal in the bush will prevent not only damage to the shaft, but also overheating from occurring. (　　)
4. The oil which causes more friction is better for high-speed bearings. (　　)
5. Sometimes, we allow oil to drip down under the influence of pressure.

Ⅲ. Fill in the blanks with the words given below. Change the form where necessary.

feed	lubricate	corrode	overheat	slide	stationary

1. No form of living speech can be ________ .
2. The waitress ________ a tray along the counter.
3. Having been working for 10 hours, the engine started to ________ .
4. Certain chemicals will ________ if left on metal.
5. I ________ the parking meter with my remaining change.
6. I need some lubricant to ________ my car engine.

Ⅳ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) lubricant	A) the force that an engine produces to push something forwards
2. ( ) oily	B) a part of machine that holds a moving part
3. ( ) stationary	C) a thick substance similar to oil, used on machine parts to make them work smoothly
4. ( ) overheat	D) looking, feeling, smelling or tasting like oil
5. ( ) bearing	E) very hard iron that breaks easily
6. ( ) cast - iron	F) to become too hot or make something too hot, sometimes causing damage
7. ( )thrust	G) not moving
8. ( )grease	H) something that makes a situation easier or more relaxed

Reading 8: Lubrication Systems

Lubrication of moving parts is important for proper functioning. Inadequate lubrication can cause additional friction, the result being overheating of parts and possible failure. There are various systems used for providing oil where needed. Some of these are listed below and discussed briefly.

(1) Bath lubrication. In this case, the bearings are completely submerged in a bath of oil. This is effective, yet it creates turbulence and prohibits proper filtering of the lubricant to remove impurities.

(2) Splash lubrication. In this type of system, rings or dippers are attached to the shaft(or made an integral part of it); when the shaft rotates, oil is scooped up from the reservoir and splashed out over the moving parts.

(3) Pressure lubrication. In this system, oil is pumped to the point where lubrication is needed. Afterwards, it is returned to a reservoir, filtered, and recalculated. During this process, it has a good opportunity to dissipate some of the heat it has acquired.

Fig. 8. 1 Multiple - feed oiler, electric solenoid control (Courtesy of Trico Manufacturing Corp.)

(4) Gravity lubrication. This can be provided in a number of different ways. One possibility is to locate a reservoir which feeds by gravity to the various key points. This may be a central oiling system leading to many bearings. One reservoir serves several lines, but if one line is clogged, one bearing receives no oil. There are several commercial

units available that have sight drip fittings; this eliminates the above - mentioned danger. Fig. 8. 1 illustrates such a device; this has a solenoid - operated control that can stop oil flow when the machine being lubricated becomes idle.

(5) Oil cups lubrication. Oil - hole covers and oil cups are available in a number of different types. Fig. 8. 2 shows some of those commonly used. They are available in threaded form or shoulder drive(the latter are pushed into a drilled hole providing a snug fit). They may be obtained with hinged covers, threaded covers(which require removing to apply oil), and spring - loaded ball valves. Oil cups are available in side feed, 45 - deg - angle feed, underfeed, as well as the conventional top - feed type.

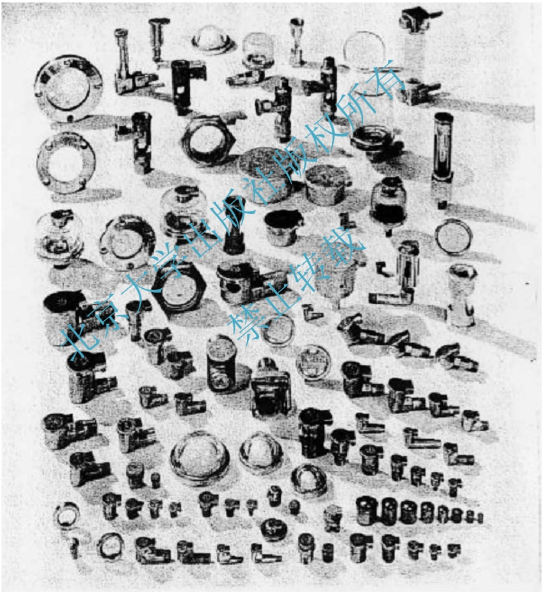


Fig. 8. 2 Miscellaneous oil cups, oil - hole covers, and sight glasses (Courtesy of Gits Bros. Manufacturing Co.)

(6) Hand feed. This system is largely outdated; it requires a man to oil by hand intermittently. Any slip - up in his schedule could cause lubrication failure and damage to mating parts.

Grooving of bushings. Oil grooves are provided in bushings to aid in supplying oil to the proper places. This is necessary because a shaft resting in a bearing squeezes out the

oil. As the shaft starts to turn, the oil is wedged against one side with an increase in pressure. Oil grooves serve somewhat as reservoirs and redistribution centers for the lubricant. Grooving is more important at low rotational speeds than at high speeds. Fig. 8. 3 shows a typical bushing with an oil groove. The edges of the groove are usually chamfered to prevent "shearing" of the oil and to provide an easier distribution.

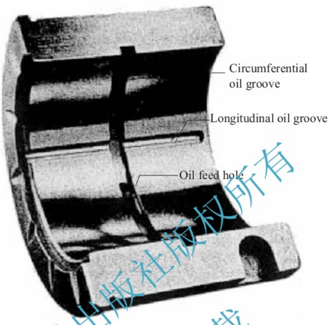


Fig. 8. 3 Bearing half showing oil grooves(Courtesy of Federal－Mogul Corp.)

参考译文：

Reading 8 润 滑 方 法

运动部件的润滑对于机器的顺利运转是很重要的。润滑不充分可能引起附加的摩擦，导致部件过热或故障。注油润滑的分类很多，下面简要讨论其中几个。

（1）浸浴润滑法。这种方法是将轴承完全浸没于油池中。该方法有效，但会引起润滑油紊流并妨碍其中杂质的过滤和清除。

（2）泼溅润滑法。这种典型分类方法是将金属圈或油匙固定在转轴上（或做成一个组合件）。随着轴的旋转，储油槽中的油被挤出飞溅到旋转的部件上。

（3）压力润滑法。这种方法是用泵将油抽至需要润滑的位置，之后经过滤、再核算，油返回至储油槽。这个过程为消耗已产生的一些热量提供了良机。

（4）重力润滑法。重力润滑法可以通过若干不同的方式来实现。一种可能是在几个关键点位置设置一个由重力供给的储油槽，这便形成了一个通向诸多轴承的中央注油系统。一个储油槽同时为几条线路供油，但若其中一条线路堵塞，就有一个轴承得不到油润滑。由于有观测油点滴的若干有效工业元件，这才消除了上述的危险。图 8. 1 描述了这样一个装置，它具有螺旋管操控功能，并在被润滑机器处于空转时停止对其注油。

(5) 油杯注油润滑法。注油孔盖和油杯种类繁多，样式各异。图 8.2 展示了一些常用的油孔盖和油杯。在若干不同类型的润滑中，注油孔端盖和油杯润滑有效且适用。螺纹和吕缘传动装置中(合乎被推进具有滑动配合的钻孔)，它们是通用的。可以利用铰链式盖、罗纹式盖(注油时盖需去除)和弹簧加载珠阀来获得。油杯注油可用于侧面进给、45°角进给、下方进给和传统的上方进给方式。

(6) 手进给注油。这种注油方法早已过时，它需要人工断断续续注油。任何一个步骤出现差错都会导致润滑失败，并使相配合零件受损。

轴套开槽。轴套内开油槽是为了辅助供油到适当位置。因为安放在轴承内的旋转轴会将油挤出，所以这是必需的。当旋转油开始起动时，润滑油随油压增加而挤入一侧，油槽作为蓄油池和润滑油再分配中心而一起作用。低速旋转与高速旋转相比，开槽更容易。图 8.3 展示了一个典型常开油槽的轴套。为阻止润滑油的剪切和实现自由的分布，该槽的棱边通常需修切边缘。

Unit 9

Text 9: Rationale for CAD/CAM

The rationale for CAD/CAM[1] is similar to that used to justify any technology-based improvement in manufacturing. It grows out of a need to continually improve productivity, quality, and, in turn, competitiveness. There are also other reasons why a company might make a conversion from manual processes to CAD/CAM:

- increased productivity
- better quality
- better communication
- common database with manufacturing
- reduced prototype construction costs
- faster response to customers

1. Increased Productivity

Productivity in the design process is increased by CAD/CAM. Time-consuming tasks such as mathematical calculations, data storage and retrieval, and design visualization are handled by the computer, which gives the designer more time to spend on conceptualizing and completing the design. In addition, the amount of time required to document a design can be reduced significantly with CAD/CAM.[3] All of these taken together means a shorter design cycle, shorter overall project completion time, and a higher level of productivity.

2. Better Quality

Because CAD/CAM allows designers to focus more on actual design problems and less on time-consuming, nonproductive tasks, product quality improves with CAD/CAM. CAD/CAM allows designers to examine a wider range of design alternative (e.g., product features) and to analyze each alternative more thoroughly before selecting one. In addition, because labor-intensive tasks are performed by the computer, fewer design errors occur. These all lead to better product quality.

3. Better Communication

Design documents such as drawings, parts lists, bills of material, and specifications are tools used to communicate the design to those who will manufacture it. The more uniform, standardized, and accurate these tools are, the better the communication will be.[4] Because CAD/CAM leads to more uniform, standardized, and accurate documentation, it improves communication.

4. Common Database

This is one of the most important benefits of CAD/CAM. With CAD/CAM, the data generated during the design of a product can be used in producing the product. This sharing of a common database helps to eliminate the age - old "wall" separating the design and manufacturing functions (Fig. 9. 1)

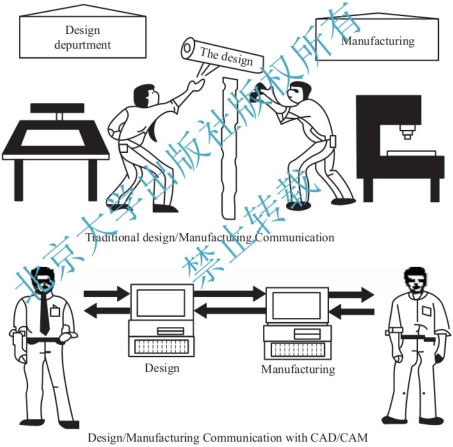


Fig. 9. 1 Traditional Design/Manufacturing Communication compared with CAD/CAM - based Communication

5. Reduced Prototype Costs

With manual design, models and prototypes of a design must be made and tested, adding to the cost of the finished product. With CAD/CAM, 3 - D computer models can reduce and, in some cases, eliminate the need for building expensive prototypes. Such CAD/CAM capabilities as solids modeling allow designers to substitute computer models for prototypes in many cases.

6. Faster Response To Customers

Response time is critical in manufacturing. How long does it take to fill a customer's order?

The shorter the time, the better it is. A fast response time is one of the keys to being more competitive in an increasingly competitive marketplace. Today, the manufacturer with the fastest response time is as likely to win a contract as the one with the lowest bid.[5] By shortening the overall design cycle and improving communication between the design and manufacturing components, CAD/CAM can improve a company's response time.

Words and Expressions

1. rationale [ˈræʃəˈnɑːl] *n.* (基本)原理
2. justify [ˈdʒʌstifai] *v.* ①证明…是正当的，认为有理 ②对齐；调整
3. manufacturing [ˌmænjuˈfæktʃəriŋ] *n.* 制造业，工业 *a.* 生产的，制造的
4. competitiveness [kəmˈpetitivnis] *n.* 竞争力
5. conversion [kənˈvəːʃən] *n.* 改变，转变，变换
6. manual [ˈmænjuəl] *a.* 手的，手工的，用手操作的 *n.* 手册，便览，简介
7. process [ˈprəuses] *n.* 过程，进程，步骤，程序 *v.* 处理，办理，用电脑处理
8. productivity [ˌprədʌkˈtiviti] *n.* 生产力，生产率
9. time-consuming [ˈtaimkənˌsjuːmiŋ] *a.* 消耗时间的
10. calculation [ˌkælkjuˈleiʃən] *n.* 计算
11. storage [ˈstɔːridʒ] *n.* 存储，记忆，存储器
12. retrieval [riˈtriːvəl] *n.* 数据检索
13. visualization [ˌvizjuəlaiˈzeiʃən] *n.* ①可视化 ②形象，形象化，想象
14. focus [ˈfəukəs] *n.* 焦点，焦距，聚光点 *vt.* 使聚焦，使集中
15. range [reindʒ] *n.* ①排，行，一系列 ②级别，等级，阶层，类别 *v.* ①排列，将...排成行 ②把...分类，使系统化
16. alternative [ɔːlˈtəːnətiv] *a.* ①两者(或若干)中择一的 ②替代的，供选择的 *n.* 可供选择的东西
17. labor－intensive [ˌleibərinˈtensiv] *a.* 劳动密集型
18. specification [ˌspesifiˈkeiʃən] *n.* ①载明，详述 ②规格，明细单，详细计划书 ③(产品等的)说明书
19. uniform [ˈjuːnifɔːm] *a.* 相同的，一致的

n. 制服，军服
v. 使成一样，使一律化

20. standardize ['stændədaiz] *v.* 使标准化，使合标准

21. accurate ['ækjurit] *a.* 精确的

22. documentation [ˌdɔkjumen'teiʃən] *n.* ①(总称)文件
②(电脑设备或软件的)使用说明

23. communication [kəˌmjuːni'keiʃən] *n.* ①传达，交流，交往，通信
②通讯(交通)设施

24. generate ['dʒenəreit] *v.* ①产生，发生(热、电、光等)
②造成，引起

25. sharing ['ʃεəriŋ] *n.* 共用，共享

26. database ['deitəˌbeis] *n.* 资料库，数据库

27. eliminate [i'limineit] *v.* ①排除，消除，消灭
②(比赛中)淘汰

28. prototype ['prəutətaip] *n.* 原型，标准，模范

29. solid ['sɔlid] *a.* ①固体的
②结实的，坚固的，坚牢的
n. 固体

30. substitute ['sʌbstitjuːt] *n.* 代替人，代替物，代用品
v. 用……代替，代替

31. response [ri'spɔns] *n.* 回答，反应

32. bid [bid] *n.* 出价，喊价，投标

33. in turn 依次，轮流；转而，反过来

Notes

1. CAD/CAM(computer aided design and computer aided manufacturing)技术是制造工程技术与计算机技术相互结合、相互渗透而发展起来的一项综合性应用技术。该技术产生于20世纪50年代后期发达国家的航空和军事工业中，随着计算机软硬件技术和计算机图形学技术的发展而迅速成长起来。1989年美国国家工程科学院将CAD/CAM技术评为当代(1964—1989年)十项最杰出的工程技术成就之一。CAD/CAM技术涉及知识门类宽、综合性能强、处理速度快、经济效益高，是当今先进制造技术的重要组成部分。CAD/CAM技术以计算机、外围设备以及系统软件为基础，综合计算机科学与工程、计算机几何、机械设计、机械加工工业、人机工程、控制理论、电子技术等学科知识，以工程应用为对象，实现包括二维绘图设计、三维几何造型设计、工程计算分析与优化设计、数控加工编程、仿真模拟、信息存储与管理等相关功能。本章主要探讨CAD/CAM的基本理论。

2. 本篇课文语法现象重点：①过去分词做后置定语；②定冠词the＋比较级的句型；③as…as的原级比较。

3. In addition, the amount of time required to document a design can be reduced significantly with CAD/CAM. 本句中 required 做后置定语，修饰主语 the amount of time。过去分词做后置定语的限定性(紧跟在修饰中心词之后)，其作用相当于限定性定语从句。该句相当于 In addition, the amount of time required (= which is required) to document a design can be reduced significantly with CAD/CAM. 本句可译为：另外，由于应用 CAD/CAM，能够减少形成设计文件所需要的时间。

4. The more uniform, standardized, and accurate these tools are, the better the communication will be. 定冠词 the+比较级的句型意为："越……越……"表示一方面的程度随着另一方面的改变而改变。本句可译为：这些工具越统一、越标准化、越精确，这种交流就会越好。

5. Today, the manufacturer with the fastest response time is as likely to win a contract as the one with the lowest bid. 该句是形容词的原级比较，…. as +形容词或副词的原级+as…，意为"前者和后者一样……"。在本句中是形容词 likely 的原级比较。本句可译为：目前，反馈时间最快的生产商很可能用较低的投标获得同样的一份合同。

Word-Study

Ⅰ. *Compound adjectives: n./a./ad. + v. ing; n./a./ad. + v. ed; n. +a.*

technology - based; time - consuming; labor - intensive;

Study the compound adjectives in the following phrases.

CAD/CAM - based communication
computer - aided process planning
computer - assisted NC part programming
computer - aided line balancing
the Egyptian foot - operated lathes
in two - dimensional cutting
a prismatic wedge - shaped tool
the metal - cutting operation
the power - transmitting components
radial load - carrying capacity
self - aligning bearing

Ⅱ. *Productivity, Productive, Nonproductive*

Productivity *n.*

① the rate of producing goods, crops, etc. ;

② the relationship between the amount that is produced and the work, money etc, that is needed to produce it.

Productive *a*. that produces well or in large quantities.

Nonproductive *a*. opposite of productive

Sentence Patterns

The	comparative degree	…,	the	comparative degree	…
The	shorter	the time,	the	better	it is
The	higher	the ductility of the workpiece material,	the	larger	the clearance angle of the tool that is needed.
The	greater	the bear load,	the	shorter	will be the life of the bearing in revolutions.
The	greater	the shaft speed,	the	shorter	will be the bearing life.
The	more uniform, standardized, and accurate	these tool are,	the	better	the communication will be.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What do CAD and CAM stand for respectively?
2. Why a company might make a conversion from manual processes to CAD/CAM?
3. How does CAD/CAM increase the productivity in the design process?
4. How does CAD/CAM improve the quality?
5. How does CAD/CAM reduce prototype costs?

Ⅱ. Complete these statements using *produce*, *product*, *production*, *productivity*, *productive*, and *nonproductive*.

1. Alternatively to improve ________, special attachments are added which reduce the flexibility.

2. New production methods have led to high ________ .

3. One of the most ________ tasks associated with manual drafting is drawing details, sectional views, or other drawing that have been previously drawn.

4. The computer not only allows workers to be more ________ but also frees them to do what only human beings can do: think creatively.

Ⅲ. Fill in each of the blanks in the following sentences with words given below. Change the forms where necessary.

focus	eliminate	manual	accurate	range

1. The ICG systems could enhance the design process by allowing the human designer to ________ on the intellectual aspects of the design process.

2. A decision table can also be used with a pre-processor to ________ some programme coding, and to provide automatic checks for completeness, contradictions and redundancy.

3. There are several ICG capabilities that make design review in CAD/CAM easier that with ________ design.

4. The benefits ________ throughout the system.

5. Not only are more ________ designs produced, but the use of design data by the quality-assurance department helps eliminate errors due to misunderstandings.

Ⅳ. Fill in the blanks with suitable words selected from the list and change the form if necessary.

automatic	create	logical	enable	productivity
store	entail	set	identification	illustrate

CAD/CAM systems can ____ a whole new ____ of drafting philosophies of which enhance ____. For instance, most systems on the market have a number of built-in functions that make new and useful drafting technique ____. Laying, for example, ____ drafters to ____ drawings in ____ segments that can be ____ separately for easy ____; but the segments can still be output together, in one single piece, which ____ the entire drawing at once. The method is analogous to the automatic drawings.

Reading 9: Computer Aided Process Planning

Traditionally process planning is performed manually by highly experienced planners who possess an in-depth knowledge of the manufacturing processes involved and the capabilities of the shop floor facilities. Because of the experience factor involved in planning for the physical reality of the product and in the absence of standardization of the process, conventional process planning has largely been subjective. Moreover, this activity is highly labour intensive and often becomes tedious when dealing with a large number of process plans and revisions to those plans. Rather than carrying out an exhaustive analysis and arriving at optimal values which would be time consuming, process planners often tend to play safe by using conservative values and this situation would invariably leads to non-optimal utilisation of the manufacturing facilities and longer lead times. They would also not be in a position to see whether a similar component has already been planned in view of the difficulties involved in going through all the old process plans.

The need for shorter lead times, satisfying varied customer demands on the product variety and the optimum use of manufacturing facilities prompted research organizations and industries to automate many functions in the product cycle. Harnessing the power of the computer is extremely advantageous in process planning since vast amount of data needs to be used for arriving at the right decision for planning the manufacturing operations.

Computer Aided Process Planning (CAPP) is a means to automatically develop the process plan from the geometric image of the component. The key to development of such CAPP Systems is to structure the data concerning part design, manufacturing facilities and capabilities into categories and logical relationships. CAPP thus appears to fully integrate CAD and CAM (Fig. 9. 2)

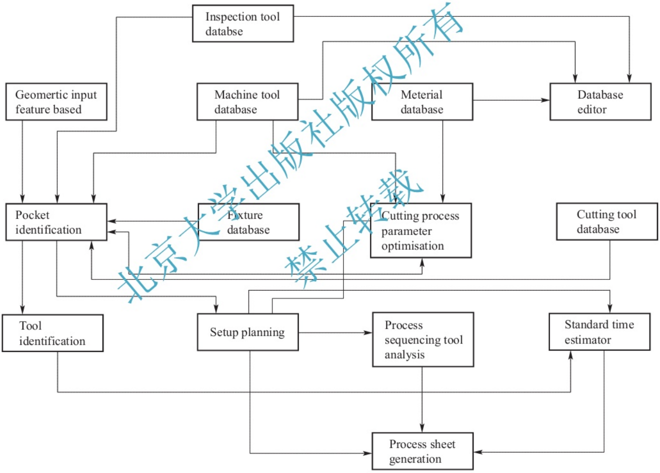


Fig. 9. 2 Architecture of a CAPP system

Approaches to CAPP

There are two basic approaches to Computer Aided Process Planning, i. e. variant and generative, which are briefly discussed below.

Variant approach

The variant approach, which is also called retrieval approach, uses a Group Technology (GT) code to select a generic process plan from the existing master process plans developed for each part family and edits to suit the requirement of the part (Fig. 9. 3). The variant approach is commonly implemented with a GT coding system. Here, the parts are

segmented into groups based on similarity and each group has a master plan.

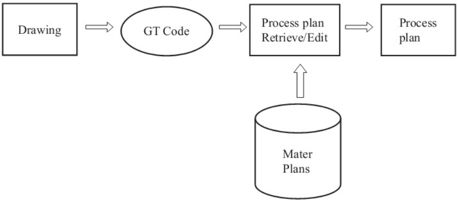


Fig. 9. 3　Variant approach to CAPP

However, this approach is impractical in situations where small batches of widely varying parts are produced. Moreover, this method fails to capture real knowledge or expertise of process planners, and there is a danger of repeating mistakes from earlier plans that were stored in the database.

Generative approach

In generative approach, a process plan is created from scratch for each component without human intervention. These systems are designed to automatically synthesize process information to develop a process plan for a part (Fig. 9. 4). These systems contain the logic to use manufacturing databases and suitable part description schemes to generate a process plan for a particular part. Most of the contemporary CAPP systems being developed are generative in nature. Generative approach eliminates the disadvantages of the variant approach and bridges the gap between CAD and CAM.

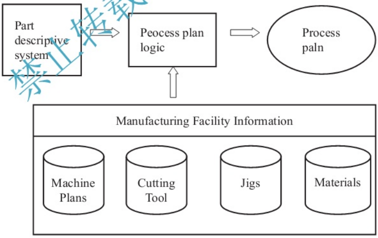


Fig. 9. 4　Generative approach to CAPP

参考译文:

Reading 9　计算机辅助工艺设计

传统意义上的工艺设计是由经验丰富的设计者手工进行的。该设计者不仅要有丰富的生产工艺知识，而且要有车间实际操作能力。由于产品的物质实际设计涉及经验因素，缺

少程序标准化，传统的工艺设计主要是出于设计者的主观想法。而且，工艺设计是劳动力高度集中的工作，当处理大量工艺设计和对该工艺设计进行修订时，该工作经常会变得冗长乏味。工艺设计者不是通过彻底的分析，也不是通过获得最理想的数值(该最理想的数值就是时间损耗)来确保设计安全，而是经常通过使用保守数值来确保设计安全。这将不可避免地导致加工设备的利用不够理想，而且会延长新产品的交货时间。鉴于在以前所有的工艺设计中所遇到的困难，设计者们甚至可能弄不清是否已经进行了同一个工艺设计。

为了满足缩短交货时间及不同客户对产品种类和加工设备最理想的利用的需求促使研究机构和企业在产品生产周期内实现自动化。要得出正确的加工工艺，必须靠计算机提供大量的数据。因此，在工艺设计中使用计算机有很多好处。

计算机辅助工艺设计(CAPP)是自动地对零件的几何图形进行工艺设计的一种方法。CAPP 系统发展的关键在于构建有关零件设计、加工设备和能力的信息，使之分类，形成相应的逻辑关系。因此 CAPP 的出现使 CAD 和 CAM 完全融为一体(图 9.2)。

CAPP 的方法

计算机辅助工艺设计的两个基本方法为变异式和创成式。下面我们简要地进行一下讨论。

变异式

变异式，也叫做检索式。用成组技术 GT(group technology)代码，从现存的、主要的工艺方案来选择一个通用的工艺方案。该工艺方案是由零件族发展而来的，根据新加工的工件特点对其进行编辑，以满足零件的需要(图 9.3)。变异式通常应用于成组技术代码系统中。因此，根据其工艺的相似性，零件归于同一零件族，每一族零件都有一个相似的加工工艺。

尽管如此，在成批生产各种零件时，使用这种方法是不切实际的。这个方法设计者没有获得真正的、专业的知识，也有重复出现以前存储在数据库中的错误设计的危险。

创成式

在创成式中，工艺设计是在无人介入的情况下，从零开始设计每个零件，自动地合成工艺信息，对零件进行工艺设计(图 9.4)。这些系统包含使用加工数据库的逻辑和合适地描述零件来完成一个特殊零件的工艺设计逻辑。

当代计算机辅助工艺设计系统，大部分是创成式。创成式消除了变异式的缺点，并且成为连接 CAD 和 CAM 的桥梁。

Unit 10

Text 10: General Design Features and Classification of Dies

Dies are classified according to their application, design features, methods of blank feeding, and scrap ejection.

With respect to application, all dies fall into cutting and shaping dies.

The former include dies for shearing, blanking, piercing, notching, trimming, and shaving; the latter are those used in bending, forming, drawing, compression, and other operations.

Classification according to applications covers the number of operations that can be performed by means of one die, grouping press tools under the headings of plain (single-operation), combination (multioperation), and progressive (multistation) dies. [1]

With respect to design the dies are divided into those without guides, those with a heel block, and those with guide posts.

According to the method of blank feeding dies can be designed either for manual or automatic feed, the method of removing finished parts allows a division of dies into those with a hole through which the part drops, the ones in which the work is ejected upwards and then removed by a positive knockout[2], and those in which the finished parts are removed by compressed air or manually.

The die design should suit the scale of production it will be used for: small-lot, large-lot, or mass production.

Dies should meet the following requirements:

(1) the accuracy and surface finish of stampings should conform to the drawings and specifications;

(2) the working parts of the die must be adequately strong, durable in operation, and easily replaceable when worn out;

(3) the die is to ensure the required hourly output, easy maintenance, safe operation, and reliable fastening in the press;

(4) the die should be designed preferably of standard components, using as few special parts as possible;

(5) the scrap in the stamping operation must be kept at a minimum.

Die components may be divided into the following types:

(a) working components, which participate in the shaping of parts (punches, dies, and their sections);

(b) structural components, which serve for joining the pieces of a die to one another and to the press (upper and lower die shoes, shanks);

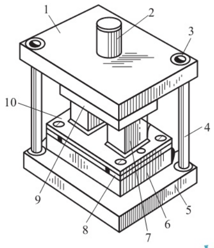


Fig. 10. 1 Press tool components

1—upper shoe; 2—shank; 3—guide - post bushing; 4—guide post; 5—lower shoe; 6—die; 7—punch; 8—positioners; 9—punch retainer; 10—stripper

(c) guiding components, which ensure accurate alignment of the punch with the die shoe in operation (guide posts and bushings);

(d) feeding components, which feed the stock or blanks to the stamping station;

(e) locating and locking components, which provide for an accurate positioning of the stock or blank in the die and fix it in place while the operation is performed;

(f) stripping components, which are intended for stripping and removing the blanks and scrap after the operation is over (strippers, knockouts);

(g) fastening components, which join and hold together all parts and units of the die (punch holders, die blocks and cases, all fasteners).

Fig. 10. 1 is a schematic representation of a press tool comprising all principal components present in any typical press tool.

Words and Expressions

1. application	[æpli'keiʃən]	*n.*	①应用，运用 ②申请
2. blank feeding			送料，给料
3. scrap ejection			废料排出
4. fall into			①分成 ②落入，注入 ③陷入
5. shaping	['ʃeipiŋ]	*n.*	①修剪 ②刨削 ③成形，造型 ④压力加工
		a.	成形的，塑造的
6. shearing	['ʃiəriŋ]	*v.*	①剪切，切割 ②剪断，剪短 ③直立截槽
7. blanking	['blænkiŋ]	*n.*	①冲截，冲割，冲压 ②落料，有料，下料

8. piercing ['piəsiŋ] *n.* 冲孔

9. notching ['nɔtʃiŋ] *n.* 做凹口，开槽

10. trimming ['trimiŋ] *n.* ①切边，修边，修整
②挤出，压出

11. shaving ['ʃeiviŋ] *n.* ①整修，刮，剃，削
②剃边(剃毛坯，剪边的毛刺)

12. compression [kəm'preʃən] *n.* ①压缩，压挤 ②压力

13. by means of 通过，依靠，凭借

14. automatic [ˌɔːtə'mætik] *a.* 自动的，机械的，半自动化的

15. adequately ['ædikwitli] *ad.* ①适当地 ②充分地，足够地

16. durable ['djurəbəl] *a.* 耐用持久的

17. maintenance ['meintənəns] *n.* 维护，保持，维修

18. preferably ['prefərəbli] *ad.* 最好，更可取的，更好的

19. alignment [ə'lainmənt] *n.* 校准，对齐

20. stock [stɔk] *n.* ①原料，材料 ②粗钢料

21. blank [blæŋk] *n.* 坯料

22. schematic [skiː'mætik] *a.* 图的，图表的，略图的
n. 图表，略图，简图

23. stamping ['stæmpiŋ] *n.* ①冲压 ②冲压件

Notes

1. Classification according to applications covers the number of operations that can be performed by means of one die, grouping press tools under the headings of plain (single-operation), combination (multioperation), and progressive (multistation) dies. 本句是一个简单句，主句为：Classification covers the number of operations。其中，according to applications 是现在分词短语，作 classification 的后置定语；宾语部分包含一个由 that 引导的定语从句，对先行词 operations 起到修饰限制作用；grouping 引导的现在分词短语作伴随状语。本句可译为：根据应用中一次冲压行程能完成的工序、工位的数目分类，将冲压工具分为平墩头的模具(单工序模)、组合模(多工序模)和级进模(多工位模)。

2. positive knockout　直接落料。指将各种塑性塑料和橡胶，如塑料异型材、管、棒、丝线、薄膜、废旧橡胶制品，放在一种塑胶设备里，将其打碎制成生产原料。粒料可直接供挤出，作为生产原料。

Word-Study

Ⅰ. *drawing*

n. ① 绘图，图，图样；

e. g. drawing paper　绘图纸
drawing board　绘图板，制图板
drawing in side sectional elevation　横剖面图
drawing instrument　绘图仪
drawing of sample　样板图
② 拔丝，拉拔，拉延；
e. g. drawing block　拉模板
drawing bench　拉床
drawing die　拉模，拉丝模，深冲模
drawing mill　金属拉丝厂、拔丝厂
drawing work　拉延工艺
drawing ratio　拉延比
drawing press　深拉压力机
③ 回火，退火；
e. g. drawing effect　回火作用
drawing furnace　回火炉
drawing process　回火过程

Ⅱ. *stamping*

n. ① 冲压，冲压件，冲压加工，模锻；
e. g. stamping article　冲压制品
stamping design　冲压设计，模锻设计
stamping hammer　冲压锤，模锻锤
stamping line　冲压生产线，模锻生产线
stamping of powder　粉末冲压
stamping of sheet metals　板料冲压
stamping press　冲床，冲压机
② 打印记；
e. g. stamping wheel　成品打印轮
stamping back　模印

Ⅲ. *knockout*

n. ① 打出，敲出，击出，推出，抖出
e. g. knockout plate　打料板，推板，顶击板
knockout rod　打料杆，推杆
knockout pin　推出销，推顶销，顶杆
② 脱模，脱壳，落砂，出芯
e. g. knockout latch　脱模锁紧销
knockout press　脱模力
knockout machine　落砂机
knockout stroke　出坯冲程

Sentence Patterns

Ⅰ. the former…, the latter

Note: the first and the second of the two people or things just mentioned. (formal)

1. The former is a painter and the latter is a composer.
2. The former is the honest and the latter the dishonest way.
3. Gases differ from solids in that the former have greater compressibility than the latter.
4. I call the former approach deductive and the latter approach inductive.
5. The former includes graphite, metallic disulfide, etc; and the latter consists of layered silicate, metallic double hydroxide etc.
6. Metals are divided into ferrous and non-ferrous metals. The former contain iron and the latter do not contain iron.

Ⅱ. 由 which 引导的非限定性定语从句

非限定性定语从句只是对主句内容，或先行词的补充、解释或附加说明。主句与先行词或从句之间一般用逗号分开，常常单独翻译。没有它，主句意思仍然完整。用 which 引导的非限定性定语从句来说明前面整个句子的情况或主句的某一部分，that 不能用于引导非限定性定语从句。

For example:

1. Moreover, it edits the calculating programs in both index Method, which gives the approximate solution and Simplex Algorithm, which gives the accurate solution.
2. The sun heats the earth, which makes it possible for plants to grow.
3. Earlier, the Babylonians had attempted to map the world, but they presented it in the form of a flattened disc rather than a sphere, which was the form adopted by Ptolemy.
4. A binary code in which sequential numbers are represented by binary expressions, each of which differs from the preceding expression in one place only.
5. The combination of satellites, which transmit information, computers, which store information, and television, which displays information, will change every home into an education and entertainment center.

Exercises

Ⅰ. Give brief answers to the following questions.

1. According to what, dies are classified?
2. What should the die design suit?
3. What requirements should dies meet?
4. How many types can die components be divided into? What are they?
5. In Fig. 10.1, could you give the names with number 1-10?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) Working component	A) knockout
2. ( ) Stripping component	B) punch
3. ( ) Fastening component	C) guide post
4. ( ) Locating and locking component	D) upper shoe
5. ( ) Structural component	E) punch holder
6. ( ) Guiding component	F) positioner

Ⅲ. Translate the following words into Chinese.

1. scrap ejection ______________
2. trimming ______________
3. positive knockout ______________
4. blank feeding ______________
5. notching ______________
6. blank ______________
7. blanking ______________
8. stock ______________

Ⅳ. Fill in the blanks with the words given below. Change the form where necessary.

application	fall into	by means of	maintenance	preferably
automatic	durable	compression	adequately	shape

1. So the battery is best kept somewhere else, ________ at room temperature.
2. The machinery requires constant ________ .
3. This heating system has an ________ temperature control.
4. This is a new discovery that had a number of industrial ________ .
5. Gold and silver are of a more ________ nature.
6. Separation is obtained ________ a series of mixers and settlers.
7. A gas is cooled by expansion and heated by ________ .
8. The materials of semicircle seamless steel tube can ________ carbon steel and stainless steel.
9. The potter ________ the clay into a vase.
10. The specimen must be ________ grounded to prevent the development of the high voltages.

Reading 10: Drawing Dies

Drawing dies come in two types, depending on the operations performed: dies for the first draw and dies for the second or following draws (redrawing dies).

The dies without blankholders are used for drawing shallow cups, as well as for drawing thick stock when there is no risk of wrinkling.

Spring or rubber - pad blankhoders are arranged in the upper part of drawing dies. They are used in shallow drawing. Dies for large and deep draws, requiring considerable pressure, are provided with a cushion built in below the lower shoe and the bolster plate. All up - to - date presses are provided with air - actuated cushions.

Drawing tools without blankholders are simple in design (Fig. 10. 2(a)); they comprise die 4 attached to the bottom of the die and punch 3 with rounded - off working edges at the bottom and shank 1 at the top for securing the punch in the press slide. For the sake of tool steel saving, die 4 is made only as thick as its working portion and placed on case 5 mounted on lower shoe 6. The lower shoe has an opening accommodating rod 8 of knockout 7. Guide plate 2 is intended to align and direct the punch.

Fig. 10. 2(b) presents a tool with a blankholder intended for the first drawing operation. The blankholder is actuated by an air pad. Draw punch 3 is arranged in the lower part of the tool lower shoe 6, while draw die 4 is secured on upper shoe 11 together with knockout 7 actuated from springs 13. The pressure against annular blankholder 10 is transferred from pneumatic pad 9 through rods 15. The air pressure in the pad is 4 - 5 atmospheres. When press

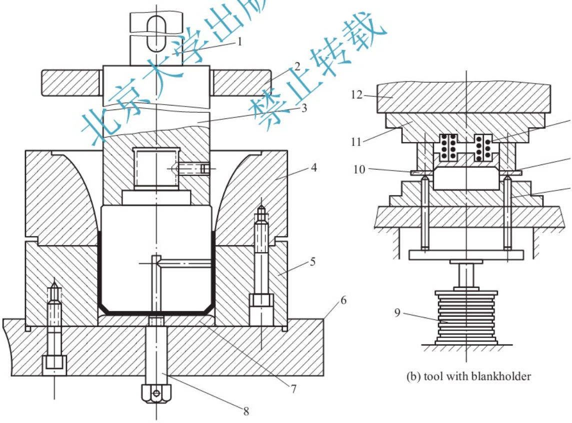


Fig. 10. 2 Drawing dies

1—shank; 2—guide plate; 3—punch; 4—die; 5—case; 6—lower shoe; 7—knockouts; 8—rod; 9—pneumatic pad; 10—blankholder; 11—upper shoe; 12—slide; 13—spring; 14—blank; 15—rods

slide 12 descends, the die face presses blank 14 against blankholder 10 and goes on travelling together with it, which makes the blank gradually slip off from under the blankholder and to form an envelope around the punch, acquiring the required shape.

Redrawing dies, like the dies for the first draw, may be with or without a blankholder.

Redrawing dies without blankholders are used only on single - action presses for a moderate decrease in the previously drawn diameter and for drawing parts of a considerable thickness. The redrawing dies are similar in design to dies for the first operation, the basic difference being that the shape and the size of the locator correspond to those of the cup made in the first operation.

Fig. 10. 3(a) shows a redrawing die without a blankholder.

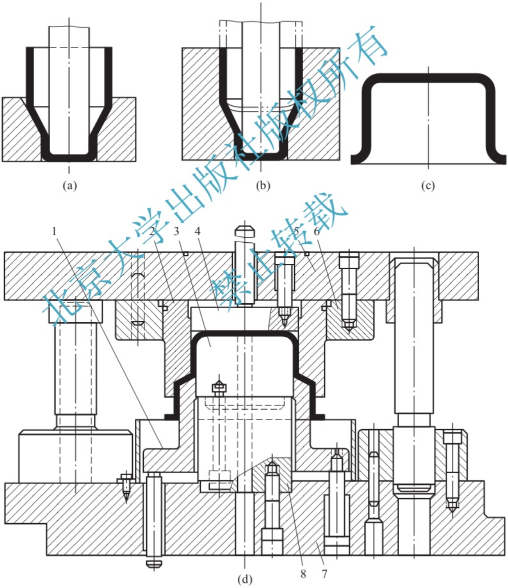


Fig. 10. 3 Redrawing dies

(a) redrawing female die; (b) elongated female die for redrawing deep cylinder without a blankholder; (c) blank after first draw; (d) redrawing die with a blankholder

1—annular blankholder; 2—die; 3—punch; 4—knockout;

5—upper shoe; 6—case; 7—lower shoe; 8—punch retainer

In multistage drawing of deep parts without a blankholder, cracks may occur at the top of the cap. This may be prevented by making use of such a die as that shown in Fig. 10. 3(b).

When making a cylindrical cup in the redrawing die shown in Fig. 10. 3(d), the blank obtained in the first drawing (Fig. 10. 3(c)) is placed on annular blankholder 1. In the downstroke of the slide, die 2 clamps the blank, then punch 3 penetrates in the blank and draws it until the blank bottom rests against knockout plate 4 which, at that moment, contacts upper shoe 5. Die 2 is held in place by case 6, while the punch is connected with lower shoe 7 through punch retainer 8.

参考译文：

Reading 10：拉　深　模

拉深模依据所执行的操作分为两种类型：首次拉深的一次拉深模和以后多次拉深模(再拉深模)。

无压边圈拉深模时常被用来拉深深浅层件，在无起皱危险的情况下，也可用于拉深厚坯。

弹簧或橡胶垫压边圈安装在拉深模的上部，用于浅拉深。对于需要相当大压力的大拉深和深拉深模，则装有坐垫，该坐垫嵌入下模座和垫板的下面。所有现代的压力机都装有气垫。

不带压边圈的拉深模在设计中是非常简单的，如图 10.2(a)所示；它们包括安装在模具底部的凹模 4、底部带有圆角的凸模 3 以及位于顶端以确保凸模沿压力机滑动的模柄 1。为了节省工具钢材料，凹模 4 被制作成只有模具工作部分的厚度，并安装在下模座 6 的凹模固定板 5 上。顶出件 7 的开放式调节杆 8 安装在下模座上。导向板 2 用于校准和导向凸模。

图 10.2(b)呈现的是带压边圈的拉深模，用于首次拉深操作。压边圈通过气垫启动。凸模 3 位于模具下模座 6 的底部，而拉深凹模 4 则和由弹簧 13 驱动的顶出件 7 一起被固定在上模座上。环形压边圈 10 的压力是通过顶杆 15 从气垫 9 传递过来的。气垫中的空气压力是 4～5 个大气压。当压力机模块 12 下降时，凹模面将毛坯 14 压向压边圈，并随其继续移动，使毛坯逐渐从压边圈下方滑出，在凸模周围形成符合要求形状的外壳。

再拉深模和一次拉深模类似，分为带压边圈和不带压边圈两种。

不带压边圈的再拉深模只能在单动压力机上，用于适度减少先前拉深的直径和拉深相当厚度的部件。再拉深模在设计上与首次拉深模类似，基本区别在于对应于首次拉深部件中的定位器的形状和尺寸。

图 10.3(a)为不带压边圈的再拉深模。

在不带压边圈的深度零件的多阶段拉深过程中，工件顶端可能会出现裂缝。关于这一点，我们可以用如图 10.3(b)所示的拉深模加以预防。

当在图 10.3(d)所示的再拉深模具中制作筒形件时，首次拉深(图 10.3(c))所获得的坯料置于环形压边圈 1 上。在滑块下冲程中，凹模 2 夹住坯料，然后凸模 3 穿入坯料中，继续拉深工件时坯料底部与顶出板接触，此时顶出板与上模座 5 接触，凹模 2 由凹模定位板 6 定位，同时凸模通过凸模定位器 8 与下模座 7 相连。

Unit 11

Text 11: Alloy Steel

Classification

Alloy steels may be defined as steels with alloying elements that exceed one or more of the following limits: 1.65Mn, 0.60Si, 0.60 Cu or aluminum., boron, chromium up to 3.99%; and containing one or more of the following elements: cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, and zirconium[2].

The nominal chemical composition of the standard AISI alloy steels were given. The carbon content was not given; however, the highest nominal carbon content is 0.95%.

In addition to the SAE - AISI code classification discussed, alloy steels may be classified as through - hardenable and surface - hardenable. Each type includes a broad family of steels whose chemical, physical, and mechanical properties make them suitable for specific product applications.

Through - hardening types are used when maximum hardness and strength must extend deep into the part.

Surface - hardening grades are used where a tough core and relatively shallow hardness are needed. These steel, after nitriding or carburizing, are used in truck transmission gears and steering worm gears - parts that must withstand wear as well as high stresses[3]. Shown in Table11.1 is a classification of the various types and uses of through - hardenable and surface - hardenable steels.

Fabricating Characteristics

Machinability. One reason for the widespread use of the alloy steels in the lower carbon range, such as 4024 and 4028, is that good machinability is obtained. The machinability drops off as the carbon content increases. For example, the machinability rating of 4023 is 70% (based on B1112 as 100%), 4032 is 65%, and 4047 is 55%. This holds true for the other alloy steels also.

Table 11.1 Classification and use of plain - carbon through, and surface - hardening steel

Type	Carbon(%)	Hardness Range	General Characteristics and Applications
Medium - carbon	0.3~0.5	Through Hardenable 250 to 400 BHN	Strength and toughness: for shafts, miscellaneous forgings, some gears (frequently cyanide) bolts, nuts flanges, bearing capes.
High - carbon	0.5~0.7	375 to 500 BHN	Strength and moderate wear resistance; for springs and collets.
Bearing	1.0	60 - 64R	High strength an high resistance to wear and scuffing: for bearings, balls, rollers, spacers, pins, and bushings.
Carburized	0.15~0.3	Surface Hardenable Case. Over 60R Core. To 45R (case. 0.15 to 0.125 in thick)	Wear - resistant case, high endurance strength, used for gear, shafts, bearings, and inspection fixture.
Flame - or induction - hardened	Over 0.4	Case. Over 55R Core. to 45R(case over 0.050 in thick)	Wear - resistant case: used for gears, pins, some gears, cages, and bushings.
Nitrided	0.3~0.5 and Nitralloys	Case. 500 to 1000 DPH Core, over 30 R(case to 0.030 in thick)	Wear - resistant case, high endurance strength some resistance to corrosion and elevated temperatures; used for shafts, gears, couplings and bushings.

Formability. Alloy steels are not usually used where forming operations other than forging are required. Here they are employed intensively for gears, bearings, crankshafts, connecting rods, axle shafts, and any other uses where good strength and toughness are necessary. These steels are often induction - hardened to provide a surface that can take high compressive loads and still have a core with great toughness.

Weldability. Weldability for alloy steels is generally good as long as the carbon content is in the low range. As the carbon content increases, preheating and postheating are often used to reduce the stress. Heat treatment after welding will help produce a uniform structure in the weld and parent metal. For most of these steels, the best results are obtained by arc welding using a low - hydrogen electrode. Reducing the hydrogen content of the weld helps to eliminate brittleness.

Castability. An important characteristic of alloy steels is their ability to air - harden. Thus, complicated castings can be obtained without quenching. Nickel and molybdenum with man-

ganese increase the capacity to air - hardening. Nickel and molybdenum with manganese increase the capacity to air - harden.

Combinations of chromium, nickel, manganese increase the capacity to air - harden produce wear resistance and high strength.

High - strength low - alloy steels

HSLA steels have become increasingly important in recent years because of the weight consciousness of automobile manufactures and of others who do not build stationary structure. These steels have been used where fatigue performance is critical; however, it is anticipated that they will be used extensively in parts, such as appliance frame members, in thicknesses of about 0.100 in. (2.54mm) which will provide a significant weight savings[4].

To be competitive with mild steel in the automotive industry, the use of hot - rolled 50ksi(345MP) S, HSLA steel must result in 10 - 20% gage reduction. An 80 ksi(550MP) S, steel must result in a 30% gage reduction. Table 11.2 indicates representative HSLA steels, listing their trade names and yield strengths.

Table 11.2 Representative trade names of HSLA bar steels(Courtesy Machine Design)

	ASTM Specification (Minimum Yield Strength)			
Producer	A242 (To 50 ksi)	A441 (To 50 ksi)	A 572 (42 to 70 ksi)	A588 (to 50 ksi)
Armco Steel	High - Strength A	High - Strength B	High - Strength C	High - Strength A - 588
Bethlehem Steel Corp.	Mayari R	Manganese Vanadium	V Steels	Mayari R 50
Inland Steel; Co.	Cor - Ten	Tri - Steel	INX Steels	Cor - Ten
Jones& Laughlin Steel Corp.	I&L Cor - Ten A	Jalten# I	JLX Steels	I&L Cor - Ten
Republic Steel Corp.	Republic 50&60	Republic A - 441	X - W Steels	Republic 50
U. S. Steel Corp.	Cor - Ten A	Tri - Ten	Ex - Ten	Cor - Ten B
Wisvonsin Steel Co.	—	—	IHX Steels	—

Basically HSLA steels are low carbon steels (maximum carbon content is 0.28%) containing small amounts of vanadium, columbium, copper, and other alloying elements. The steels gain their strength through controlled cooling and inclusion shape control. Controlled cooling is done by the steel mills as the hot steels or bars are laying on the runout table. The inclusion shape control changes the inclusions in hot - rolled steels from stringers to round globules through the addition of zirconium or rare earths to the steels during deoxidation.

Words and Expressions

1. nominal	['nɔminəl]	*a.* ①名义上的，有名无实的
		②(金额)很少的，象征性的
2. composition	[ˌkɔmpə'ziʃən]	*n.* ①构图，构成，成分
		②作文，作品
3. property	['prɔpəti]	*n.* ① 性质，特性，性能
		②财产，资产，所有物
4. nitride	['naitraid]	*n.* 氮化物
		v. 渗氮
5. carburize	['kɑ:bjuraiz]	*v.* 给(铁)加碳
carburizing		*n.* 增碳剂，渗碳剂
6. wear	[wɛə]	*n.* ①磨损，损耗 ②穿，戴
		v. ①磨成，擦成，
		②穿着，戴着
		③呈现，显出
7. machinability	[məʃi:nə'biliti]	*n.* 可模锻性，可成形性
8. formability	[fɔ:mə'biliti]	*n.* 可模锻性，可成形性
9. forge	[fɔ:dʒ]	*vt.* ①锻造 ②伪造，仿造
		vi. 突然向前
		n. ①锻造车间，铁匠铺 ②熔铁炉
10. induction－hardened		火焰或感应淬火
11. weldability		*n.* 焊接性，可焊性
12. uniform	['ju:nifɔ:m]	*a.* 统一的，全都相同的，一律的
		n. 制服，校服
13. arc	[ɑ:k]	*n.* ①弧，弧线，弧形 ②弧形物
		v. ①作弧形运动 ②形成电弧
arc welding		电弧焊
14. electrode	[i'lekˌtrəud]	*n.* 电极
15. castability		*n.* 铸造性，可铸性，铸造质量
16. air－harden		空气硬化
17. casting	['kæstiŋ]	*n.* ①铸造(物) ②投，掷
		③放弃，蜕皮
cast	[kɑ:st]	*v.* ①垂钓，放钓 ②浇铸
18. fatigue performance		疲劳性能
19. hot－rolled		热辊压榨的
20. gage	[geidʒ]	*n.* ①厚度，直径 ②测量仪表
		v. ①计量，度量 ②估计，判断
21. runout	['rʌnˌaut]	*n.* 避开，逃开

22. stringer [ˈstriŋə] *n.* 上弦匠，长条支承木材
23. globule [ˈglɔbjuːl] *n.* 小球，水珠
24. zirconium [zəːˈkəuniəm] *n.* 锆
25. deoxidation [diːˌɔksiˈdeiʃən] *n.* 脱氧
26. set [set] *n.* ①凝固，凝结
②(一)套，(一)副
vt. ①放，搁置 ②设置，调整好；
vi. ①凝结，凝固，固定，定型
②(日、月等)落，下沉

Notes

1. 本篇课文涉及机械工程热加工基础，课文题目：合金钢。

2. Alloy steels may be defined as steels with alloying elements that exceed one or more of the following limits：1.65Mn，0.60Si；0.60 Cu or aluminum.，boron，chromium up to 3.99%；and containing one or more of the following elements：cobalt，columbium，molybdenum，nickel，titanium，tungsten，vanadium，and arconium.

本文出现了很多的化学元素，本句可译为：合金钢可定义为钢中的合金元素有一种或多种超过下述限值：1.65Mn；0.60Si；0.60 Cu 或者铝、硼和铬的含量达到 3.99%；同时还包含一种或多种下述元素：钴、铌、钼、镍、钛、钨、钒及锆。

3. These steel，after nitriding or carburizing，are used in truck transmission gears and steering worm gears - parts that must withstand wear as well as high stresses.

本句是被动句并且“after nitriding or carburizing”在句中做插入成分。本句可译为：经过氮化或碳化后的这些钢材通常用于制造卡车传动齿轮及蜗轮传动装置的零件——这些零件必须抗磨损和承受高应力。

4. These steels have been used where fatigue performance is critical；however，it is anticipated that they will be used extensively in parts，such as appliance frame members，in thicknesses of about 0.100in.（2.54mm） which will provide a significant weight savings.

本句是复合句，从句是被动句；主句中 it 是形式主语，真正的主语是后面 that 引导的主语从句，在主语从句中由 which 引导的定语从句修饰 in thicknesses of about 0.100in（2.54mm）。本句可译为：这些钢可用于失效性能较剧烈的部位。但是，预计它们将广泛应用于零部件，如厚度约为 0.100 寸可以有效地节省重量(2.54mm)的设备部件。

Word-Study

Ⅰ. ***Relieve*(=*to make less severe*)**

When the pressure in a boiler becomes too great，we can relieve it by allowing some of the steam to escape.

We can relieve the stresses in a steel bar by tempering it.

Ⅱ. *Critical*

(1) = decisive(point or stage)and therefore important or serious.

(2) = a decisive point in temperature, pressure or angle at which something is about to happen.

The critical temperature of steel: above or below this temperature the molecular structure changes.

The critical temperature of a gas: above this temperature it cannot be liquefied by pressure.

The critical pressure: the pressure at which a gas can be liquefied.

Ⅲ. *Conducive, helpful*

(1) Regular maintenance is	conducive to (helpful to)	better performance of the machine.
(2) Good labor relations are		improved production.
(3) Turbulence in the cylinder is		more efficient burning of the gases.

Ⅳ. *Apply (=put on)*

(1) A pressure of x lb. /in^2 is	applied	to the piston.
(2) When pressure is		to the ice, some of it will melt.
(3) Insulation should be		to the wire in the form of a paste.
(4) Grease may be		to the bearings with a grease gun.
(5) This principle was successfully		to the design of high - speed aircraft.

Sentence Patterns

Ⅰ. *Maximum and Minimum*

(1) a. The maximum temperature / The upper temperature limit
b. The minimum temperature / The lower temperature limit
c. The average temperature
d. The temperature range

in this country is about

35℃.
0 ℃.
17. 5℃.
35℃.

e. The temperature in this country ranges/varies from 35℃ to 0℃.

(2) a. In summer the temperature rises/increases. There is a rise/an increase in temperature.

b. In winter the temperature falls/drops/decreases. There is a fall/drop/decrease in temperature.

c. By heating/cooling a substance, we can raise/lower its temperature to boiling/freezing point.

(3) a. The maximum pressure in the boiler is 500lb/in^2.

b. The maximum speed of the aircraft is 800 m. p. h. (miles per hour).

c. The maximum fuel consumption of the engine is 30 m. p. g. (miles per gallon).

d. The maximum speed of the turbine is 8000 r. p. m. (revolutions per minute).

e. The maximum diameter of the tube is 9/16inch.

Ⅱ. ***Methods***

(1) a. Welding is one of joining pieces of metal together.
means
method
Way

b. There are many of joining pieces of metal together.
methods
ways
Means

c. One of the best of joining pieces of metal together is to weld them
methods
ways
means

(2) New methods of production were a few years ago.
adopted
put into practice
employed
installed
introduced

Exercises

Ⅰ. Give brief answers to the following questions.

1. What's the definition of Alloy Steels?
2. What is the highest carbon content in alloy steels?
3. How many characteristics of alloy steels? What are they?
4. What is maximum carbon content of HSLA steels?

Ⅱ. Match the items listed in the following two columns.

Column A	**Column B**
1. ( )nitride	A) 锻造
2. ( )forge	B) 统一的，全都相同的
3. ( ) wear	C) 铸造性
4. ( )weldability	D) 弧
5. ( )uniform	E) 焊接性
6. ( )electrode	F) 磨损，损耗
7. ( )arc	G) 氮化物
8. ( ) castability	H) 电极

Ⅲ. Transfer following sentences to passive voice.

1. Bruce writes a letter every week.
2. Lilei mended the broken bike this morning.
3. He has written two novels so far.
4. They will plant ten trees tomorrow.
5. Lucy is writing a letter now.
6. You must lock the door when you leave.

Reading 11: Metal - Casting Processes

Most metal castings are made by pouring molten metal into a prepared cavity and allowing it to solidify. The process dates from antiquity.

The largest bronze statue in existence today is the great Sun Buddha in Nara, Japan. Cast in the eighth century, it weighs 551 tons (496 metric tons) and is more than 71 ft (21m) high.

Artisans of the Shang Dynasty in china (1766—1222 b. c.) created art works of bronze with delicate filigree as sophisticated as anything that is designed and produced today. In the Cauca valley in Columbia, aboriginal Quimbaya gold - smiths created remarkable hollow gold castings long before the time of Columbus.

There are many casting processes available today and selecting the best one to produce a particular part depends on several basic factors such as cost, size, production rate, finish, tolerance, section thickness, physical - mechanical properties, intricacy of design, and weldability.

Casting processes may be classified into seven groups: sand casting, shell molding, plaster molding, investment casting, permanent - mold casting, die casing, and continuous casting.

Sand casting

Green - sand molding process. Green - sand molding is the most frequently used casting process and therefore will be discussed in more detail than some of the other processes.

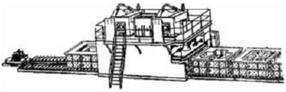
Green sand refers to moist sand (from 2 to 8% water). This method of molding is the most popular and widely used process in the foundry industry. The process is well suited to a wide variety of miscellaneous casting, in sizes of less than a pound to as large as 3 to 4 tons. This versatile process is applicable to both ferrous and nonferrous materials.

Green sand can be used to produce intricate molds since it provides for rapid collapsibility, that is to say the mold is much less resistant to the contraction of the casting as it solidifies than other molding processes. This results in less stress and strain in the casting.

Dry - sand casting. Most large and very heavy castings are made in dry sand molds. The mold surfaces are given a refractory coating and are dried before the mold is closed for pouring. This hardens the mold and provides the necessary strength to resist large amounts of metal, but it increases the manufacturing time.

Molds that are hardened by a carbon dioxide process, can also be considered in the dry – sand class. The process of sand casting begins with the design, which in turn is made into a three – dimensional pattern. The pattern can be made of wood, metal , plaster, styrofoam, or other materials. It is made larger than the desired casting to provide for metal shrinkage. distortion, and machining. In hand molding the pattern is placed on a molding board, which is a little larger than the open box or flask in which the sand mold is to be made. The molding board is placed under the top half of the two – part flask and sand is poured around the pattern. The sand next to the pattern is always sifted or riddled to provide a better detail and is termed facing sand.

The sand is rammed or compacted around the pattern by a variety of methods including: hand or pneumatic – tool ramming, jolting (abrupt mechanical shaking). Squeezing (compressing the top and bottom mold surfaces), and driving the sand into the mold at high velocities (sand slinging). Sand slingers are usually reserved for use in making very large castings where great volumes of sand are handled (Fig. 11. 1). The jolt and squeeze method of filling the flask, usually a two – part box containing the pattern, is by far the most used. First the drag, or lower half of the flask, is filled and jolted, then the flask is turned over, the cope, or top half of the flask, is filled, and the two – part mold, with the pattern and molding board sandwiched in between is squeezed.



Sandslinger–medium and lurge castings

Fig. 11. 1　A sand sandslinger can be used to fill large floor molds or a number of smaller molds in a relatively short time

Patterns. Patterns of simple design. With one or more flat surfaces, can be molded in one piece, provided that they can be withdrawn without disturbing the compacted sand. Other patterns may be split into two or more parts to facilitate their removal from the sand when using two – part flasks.

The pattern must be tapered to permit easy removal from the sand. The taper is referred to as draft. When a part does not have some natural draft, it must be added. A more recent innovation in patterns for sand casting has been to make them out of foamed polystyrene that is vaporized by the molten metal. This type of casting, known as the full – mold process, does not require pattern draft.

Sprues, Runners, and gates. Access to the mold cavity for entry of the molten metal is provided by *sprues*, *runners*, *and gates*, as shown in Fig. 11. 2. A pouring basin can be carved in the sand at the top of the sprue, or a pour box, which provides a large opening, may be laid over the sprue to facilitate pouring. After the metal is poured, it cools most rapidly in the thin sections and along the outer surfaces where it gives up most of its heat to the sand mold. Thus the outer surface forms a shell that permits the still molten metal near the center to flow toward it. As a result the last portion of the casting to freeze will be deficient in metal and, in the absence of a supplemental metal – feed source will result in some

form of shrinkage. This shrinkage may take the form of gross shrinkage (large cavities) or the more subtle microshrinkage (finely dispersed porosity). These porous spots can be avoided by the use of risers, as shown in Fig. 11. 2. which provide molten metal to make up for shrinkage losses.

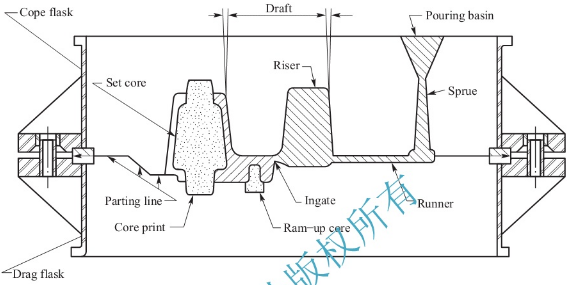


Fig. 11. 2　Sectional view of casting mold

参考译文：

Reading 11　金属铸造流程

制造金属铸件时，通常是将熔融金属浇铸到一个预制的空腔中，然后让其凝结化。这种方法可以追溯到古代。

目前现存最大的铜雕像是位于日本奈良的大日如来像，它铸造于8世纪，重达551吨(496公吨)，高度达71英尺(21m)以上。

中国商代(公元前1766—1222年)的工匠用细丝工艺创作铜材艺术作品，非常精致，能够与今天设计及生产的作品相媲美。在哥伦比亚考加河谷，原始琼巴亚金匠在哥伦比亚时代很久以前就创造了卓越非凡的中空金质铸件。

今天，有许多种有效的铸造方法，为了生产某一特殊的部件，选择哪种方法最好取决于多个基本因素，如成本、尺寸、生产率、光洁度、公差、截面厚度、物理机械特性、设计的复杂程度以及可焊接性。

铸造方法可以划分为七类：砂铸法、壳模铸造法、石膏模铸造法、熔模铸造法、永久模铸造法、压铸法和连续铸造法。

砂铸法

湿砂模铸法

湿砂造模铸造法是应用最广泛的铸造方法。因此，相比其他方法，需要更加详细地探讨。

湿砂指的是潮湿的砂子(水含量在2%～8%)，这种造模方法在铸造业中最流行，且应用范围也最广泛，能够满足多个领域的多种铸造，其适用尺寸可以轻至1磅以下，重达3吨到4吨。这种通用方法既适用于黑色金属材料又适用于有色金属材料。

由于湿砂具有高速溃散性，它常用于制造复杂的铸模，也就是说，与其他模铸方法相比，固化时铸模可承受更小的铸造收缩力，因此，在铸造中会导致较小的应力和应变。

干砂铸造法

最大多数重大型铸件都采用干砂模铸造。铸模浇铸具闭合前，其表面涂以一层耐火材料，并进行干燥处理。这样能使铸模硬化，提供必要的强度以抵抗大量金属的冲击。但是，这样就增加了制造的时间。

采用二氧化碳加工生产硬化的铸模也可看作干砂铸造种类，这种砂铸工艺从设计入手，依次制成三维模型。这种模型可由木材、金属、石膏、泡沫聚苯乙烯或其他材料制成。模型比理想的铸件大些，用来满足金属收缩、变形及机械加工的需求。在手工造型中，模型安放在铸模板上，铸模板比开箱或在其内将制作砂铸模的砂箱稍大些。铸模板置于两砂箱的上层之下，砂子灌注在模型的周围，邻近模型的铸砂常常经过筛分挑选或筛网处理，用以提供较好的细砂，通常术语称这种细砂为面砂。

可以使用多种方法将砂子夯实或者压紧在模型周边，其中包括：手动或气动工具夯实、震击捣砂(突变机械振动)、挤压(压紧顶层或底层铸模表面)、高速度将砂子驱入铸模之中(抛砂法)。铸造大型铸件时，通常保留抛砂机，用于处理大量铸砂时使用(图11.1)。填充砂箱的振动及挤压法通常应用于包含模型的一个两分箱，是目前应用最为广泛的方法。首先，将下砂箱或下半砂箱填充并震实；然后翻箱填充上砂箱或上半砂箱，将两分开的铸模与模型以及夹在它们之间的铸模板挤压在一起。

模型

简单设计的模型是利用一个或更多展开表面的一部分，可以在其内制模，且规定在不扰动实密型砂的情况下，这些表面部分能被抽出。使用双箱砂箱时，其他的模型可以分为两个或多个部分，以方便它们从型砂中移出。这种模型必须逐渐变细，具有斜度，保证其能够轻松地从型砂中移出，这种逐渐变细的斜度，通常称为起模斜度。当模型一部分不含某些自然的起模斜度时，必须添加。最近关于砂型铸造中的模型创新已使它们能从发泡的聚苯乙烯中分离出来，且这种聚苯乙烯能被熔融金属汽化掉。这种铸造方式称为实模铸造法，它不要求模型具有起模斜度。

主流道、分流道、浇口

用于进入熔融金属的铸型空腔通道由主流道、分流道和浇口提供，如图11.2所示。在主流道或倾倒箱上边的型砂中可以开拓出一个浇注槽，它提供较大的入口，安置于主流道上方，以便浇铸。金属浇铸后，在非常薄的截面上迅速冷却，沿着外表面将大部分热量传递给砂模，因此外表面形成一个壳体，能够容许熔融金属流向壳体中心附近。因此，凝固铸件最后部分金属中有缺陷。同时，因为缺少用于补充金属材料的添加源，导致某种形式的收缩，其形式可能是粗大性缩孔(大腔)或者是非常细微的显微缩孔(非常分散的缩孔)。这些多孔点可以通过(图11.2)冒口加以避免，它们能够应用熔融金属对收缩的损失加以补充。

Unit 12

Text 12: Fusion Welding – Process Variables

The present scale of modern, welded construction is really quite staggering. The new 6000 km pipelines used to transport natural gas from the other side of the Ural Mountains to Western Europe, the giant 100000 ton supertankers, the oil platforms, and the aluminum liquid–gas storage tanks and rolling stock are just a few of the more impressive examples. The wide range of materials used to build these huge constructions have all to meet rigid specifications of high strength, good toughness and often resistance against corrosion and fatigue. Most importantly, however, it is essential that the materials possess good weldability.

What is really meant by 'good weldability'? There have been numerous discussions among the various welding commissions as to its exact meaning. Some people even argue that since virtually all metals and alloys can be welded, the term may even be redundant! However, this point of view is rather academic since, in practice, materials are generally considered to possess good weldability only if they can be reliably welded on a production scale. As such, the term *good weldability* has to be a function of a number of interacting factors, which include:

1. Type of welding process.
2. Environment.
3. Alloy composition.
4. Joint design and size.

All these factors can be decisive to the alloy's weldability and if one of them is unsuitable it may give rise to cracking problems. Indeed, weldability is often defined simply in terms of susceptibility to the various types of cracking problems known to be associated with welds[1]. Thus, the use of empirical equations which describe an alloy's susceptibility to a certain types of cracking problem in terms of its composition, and in more complicated cases, in terms of a number of interacting parameters, such as carbon equivalent, heat in-

put, preheat temperature, joint type, etc, is often advocated; this approach is examined in more detail later. In this chapter weldability is considered in terms of the various process variables of fusion welding and the weld thermal cycle.

Fusion Welding

By far the most important technique used in welding construction today is fusion welding, which is the main process discussed herein[2]. For descriptions of these and other welding processes *see*, e. g. , Lancaster and Tylecote for solid-phase welding and Crossland for a review of explosive welding. It is not intended to delve deeply into the metallurgy of fusion welding, but instead to discuss some of the factors that may affect the microstructure and properties of welds.

Fig. 12. 1 illustrates one of the most common of the fusion welding process: *manual metal arc* welding (MMA). The heat source is provided by an *electric arc*, a high current and a low voltage discharge in the range of 10～2000A and 10～50A. The *electrode* consists of a core of filler wire and a *flux* coating, composed of various silicates and metal oxides. During welding the flux melts to form a viscous *slag*, which provides a protective layer between the atmosphere and the molten metal. In addition, the slag creates a chemically reducing environment which helps to exclude elements in the air and to prevent moisture from penetrating the weld pool. It may also generate gasses which help maintain the flow of liquid metal droplets from the filler wire to the pool. The slag has to adequately cover the melt, even in vertical welds, and so its composition is critical as this affects the viscosity.[3] Afterwards, the slag must also be easily detachable from the solidified weld surface.

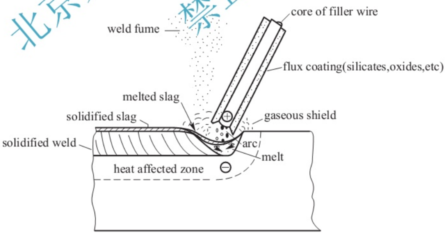


Fig. 12. 1 Principle of the manual metal arc welding process. Melting and vaporization of the flux coating provide a protective shield from the atmosphere

Other welding processes, such as *submerged arc* (SA), employ a separate slag feeding process, but the principle is the same as for MMA welding. A protective atmosphere may also be generated in the form of an inert gas as, for example, *in metal-inert gas* (MIG) welding. Alternatively, welding may be carried out in a vacuum as in electron beam welding.

It is important to note the different roles of the slag when comparing *arc welding* with

electroslag welding. In electroslag welding the slag plays an essentially different role from normal arc welding in that heat is generated by *resistance heating* of the slag. Thus, fluxes are chosen with respect to their effect on electrical conductivity and viscosity of the slag. In terms of heat input the electroslag process has a much larger heat capacity, and the heat source moves more slowly than in other fusion welding processes.

In order to appreciate the effect of the variables in fusion welding on the characteristics and properties of welded joints it is worth examining the principles of consumable development in more detail.

Words and Expressions

1. staggering	['stægəriŋ]	*a.* 难以置信的；令人震惊 *ad.* 难以置信地；令人震惊地
2. Ural Mountains		乌拉尔山脉
3. redundant	[ri'dʌndənt]	*a.* ①因人员过剩而被解雇的 ②不需要的；多余的
4. susceptibility	[səseptəbiliti]	*n.* 感受性，易感性，敏感性 【物】磁化系数，磁化率 【医】感病性；感药性
5. parameter	[pə'ræmitə]	*n.* ①(限定性的)因素，特性，界限 ②参量，参数
6. thermal	['θə:məl]	*a.* 热的，热量的，由热造成的
7. delve	[delv]	*v.* 深入探究，钻研
8. metallurgy	['metlə:dʒi:]	*n.* 冶金学
9. current	['kʌrənt]	*n.* ①电流 ②水流，气流 ③流，流动 *a.* ①现在的，现行的②通用的
10. voltage	['vəultidʒ]	*n.* 电压，伏特数，电位差
11. discharge	[dis'tʃɑ:dʒ]	*n.* ①排放出的物体 ②获准离开，释放 ③卸船，(船的)卸货 *v.* ①卸船②偿还
12. electrode	[i'lektrəud]	*n.* 电极
13. silicate	['silikit]	*n.* 硅酸盐
14. oxide	['ɔksaid]	*n.* 氧化物
15. reducing environment		还原环境
16. moisture	['mɔistʃə]	*n.* 水分，水气，湿气 *v.* 使防潮
17. droplet	['drɔplit]	*n.* 小滴
18. slag	[slæg]	*n.* 矿渣，熔渣

		v. (使)成渣(状)
19. solidify	[sə'lidəfai]	vt. (使)成为固体，(使)变硬，
		vi. 凝固
20. viscosity	[vi'skɔsiti:]	n. ①黏稠，黏性 ②黏质，黏性
21. feed	[fi:d]	vt. ①加进(原料等)，供…以原燃料 ②喂养，为…提供食物
		vi. 吃，以…为食
		n. ①饲料(尤指粗饲料) ② 喂送；进料；给水
22. appreciate	[ə'pri:ʃieit]	v. ①对…作(正确)评价，鉴别 ②(充分)意识到，觉察，注意到

Notes

1. Indeed, weldability is often defined simply in terms of susceptibility to the various types of cracking problems known to be associated with welds. 这句话是被动句。可译为：的确，人们通常依据与焊缝相关的各种开裂问题的敏感性，简单地对焊接性进行定义。

2. By far the most important technique used in welding construction today is fusion welding, which is the main process discussed herein. 本句中出现了由 which 引导的非限定性定语从句。可译为：到目前为止，焊接施工中使用的最主要工艺就是熔焊，这也是本文讨论的主要焊接工艺。

3. The slag has to adequately cover the melt, even in vertical welds, and so its composition is critical as this affects the viscosity. 本句可译为：黏性渣必须充分覆盖熔化的金属，即使在立式焊中也是如此。因此黏性渣的成分非常关键，因为这将影响到其黏性。

Word-Study

Ⅰ. *Negligible*, *Considerable*, *Substantial*, *Appreciable*, *Material*

A negligible amount of something is very small.

It is so small that we can neglect or ignore it.

A considerable / An appreciable / A substantial / A material } amount of something is quite large.

An appreciable amount is large enough to be worth appreciating or noticing.

A considerable amount is large enough to be worth considering or noticing.

A substantial amount is large enough to be noticed, like a substance.

A material amount is large enough to be noticed, like a material.

Ⅱ. *Melt, Molten, smelt*

Ice－cream melts in the sun.
Ice melts in the summer.
The melted ice comes down the mountain in rivers.
At a certain temperature, metals melt. They become molten.
The molten iron passes out of the furnace into moulds.
We smelt iron ore by heat, and change the ore into its metal stare.
During smelting, the temperature in the furnace is raised and the iron melts.
When the ore is smelted, it becomes pig－iron.

Sentence Patterns

Ⅰ. *Quantity*

<table>
<tr><td rowspan="4" colspan="2">The earth contains</td><td colspan="3">little
not much
a little
some</td><td rowspan="4">uranium.

Iron ore.</td></tr>
<tr><td rowspan="2">a</td><td>small
moderate
certain</td><td rowspan="2">amount of</td></tr>
<tr><td>large
great
considerable</td></tr>
<tr><td colspan="3">a great deal of
a lot of
plenty of</td></tr>
<tr><td>The engine
The motor</td><td>produces</td><td>a</td><td>certain
negligible
small
moderate
considerable
large
great</td><td>amount of</td><td>power.</td></tr>
</table>

<table>
<tr><td>A</td><td>certain
moderate
considerate
considerable
large</td><td>percentage
proportion
part
quantity
amount</td><td>of the world's coal lies
in this country.</td></tr>
</table>

Ⅱ. Contents (Contain, Consist, Comprise, Constitute, Include, Compose, Made up, Resolve)

1. The packet } contains { 20 cigarettes.
2. The gas } contains { about 5.5% of carbon monoxide.
3. The alloy } contains { 5% nickel and 5% iron.
4. The tank } contains { 100 gallons of oil.
5. The carbon monoxide } content { was about 5%.
6. The moisture } content { of the cylinder increased.
7. Part of the heat } content { of the gases is lost.
8. He emptied out the contents of the box.
9. A tank is a large container for holding liquids.
10. The class consists of twenty - four students.
11. The atmosphere comprises a number of gases.
12. The machine is composed of several different parts.
13. Cast - iron is made up of about six different substances.
14. The factory produces components for aircraft.
15. The resultant force acting on an aircraft wing may be resolved into vertical component and a horizontal component.
16. The composition of cast - iron is different for different purposes.
17. Twenty - four students constitute the class.
18. A number of gases form the atmosphere.
19. Ferrite and carbon made up mild steel.
20. Ferrite and carbon are the constitutes of mild steel.
21. The students in the class include three from Germany and four from France.
22. The gases in the atmosphere include oxygen and nitrogen.
23. The mixture in the furnace includes a certain amount of limestone.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What factors can be decisive to the alloy's weldability?
2. Why it is redundant to define the term "good weldability"?
3. What is the most important technique used in welding construction today?

Ⅱ. Translate the following words into Chinese.

1. electrode ____________
2. oxide ____________
3. moisture ____________
4. droplet ____________
5. viscosity ____________
6. solidify ____________

7. feed ________________
8. thermal ________________

Ⅲ. Answer these questions, using an appropriate phrase from the table.

1. How many substances are present in iron ore?
2. What proportion of countries use electricity from nuclear power station?
3. How much carbon does wrought – iron contain?
4. How much power do you need to drive a large liner through the water?
5. Are there many gold fields in the world?
6. How much petroleum if pumped out of the ground every year?
7. What percentage of people in your country work in factories?
8. Are any metals besides ferrous metals used in industry?
9. How much oxygen is needed to burn a ton of coal?
10. How much soil do the rivers carry down to the sea in a year?

Ⅳ. Complete these statements with the proper "content" word.

1. The metal which we find in the earth ________ iron, lead and copper.
2. The carbon ________ of wrought – iron is very low.
3. We know the chemical ________ of the liquid from previous analysis.
4. Smelting ________ of heating the iron ore in a furnace and removing the slag.
5. The ________ of moulding sand ________ quartz, feldspar and mica.
6. The atom ________ a nucleus, and electrons moving round it in space.
7. All matter ________ of atoms.
8. Metals which we use widely in industry ________ aluminium and steel.
9. We can discover the ________ gases of fuel by chemical analysis.
10. The total floor space of the factory ________ 20, 000 square feet on two floors.

Reading 12: Methods of Joining Materials

At about the time that Diogenes, the original Cynic, was living in his tub, a fellow Greek, Archytas of Tarentum, is believed to have invented the screw. By the second century B. C. this device was being used extensively by the Greeks in their wine presses. Whilst a less exotic use was made of the screw by Archimedes in his machine for raising irrigation water. Strangely, no one seems to know when the screw was first used as a fastening device.

Primitive man experienced great difficulty in joining his materials. He used sinews and thongs of hide to tie together the frameworks of his huts and also to tie on the heads of his stone axes. By 3000B. C., however, the coppersmiths of Egypt were producing nails whilst, a little later, the woodworkers of that region were using quite sophisticated six – layer plywoods cemented by animal glues. Almost certainly by 3000 B. C. the smith had mastered the art of pressure welding using hammer and anvil but it was less than a century

ago that the development of welding technology, as we now understand it, really began.

Nailing and screwing

Nailing is used mainly in the joining of soft woods in building construction and is effective because of the fairly high elasticity of wood. A nail driven wedge – fashion into wood gives rise to a region of considerable elastic strain around the nail. In turn this elastic strain causes lateral pressure on the surface of the nail and resultant forces of friction oppose its withdrawal.

Screwing is more satisfactory because greater strain energy can be produced by the spiral – wedge action of the screw thread. This in turn involves greater forces of friction between wood and screw as compared with those between wood and nail. Moreover the force required to separate the joined members will be greater since the forces opposing friction between screw and wood is only that component of the separating force which is resolved along the 'inclined plane' of the screw. For this reason metals can also be joined successfully by screwing.

Riveted joints

Despite the increased use of welding as a means of joining materials riveting is still important, particularly in shipbuilding and structural engineering. Most readers who have studied elementary applied mechanics will know that the design of a riveted joint involves equating the strength of the rivets themselves with the strength of the pierced plates.

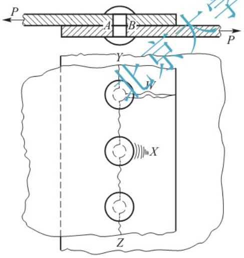


Fig. 12. 2 Modes of failure of a simple riveted lap joint

Consider a simple riveted lap joint (Fig. 12. 2). This may fail in any one of the following ways:

(i) the plate may split beneath the rivet (at W). To prevent this type of failure it is customary to make the distance from the centre of the hole to the edge of the plate not less than 1. 5 times the diameter of the rivet;

(ii) the plate may 'crush' at X;

(iii) if the rivet holes are too close together one of the plates may tear through the line YZ;

(iv) if the rivets are too small they may shear along AB.

To design a joint in the most economical manner it should be on the point of failing in all four of these ways simultaneously. Lap joints may be single or double riveted (Fig. 12. 3) but it is unusual to use more than two rows of rivets. The *pitch* is the distance between centres of rivets measured along a row. The strength of the joint may be calculated by considering a strip equal in width to the pitch (Fig. 12. 4).

Let $p=$ pitch of rivets;

$d=$ diameter of rivets;

$t=$ thickness of plates;

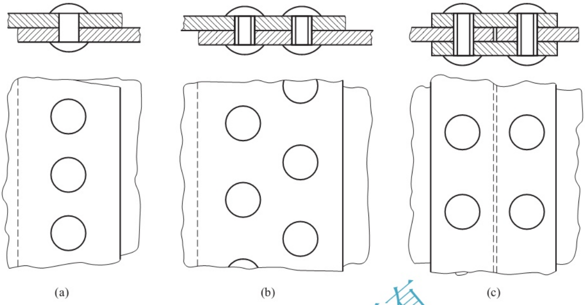


Fig. 12. 3 Some types of riveted joint

(a) simple riveted lap joint; (b) double riveted lap joint; (c) single riveted butt joint

(Both lap and butt joints may be single or double riveted)

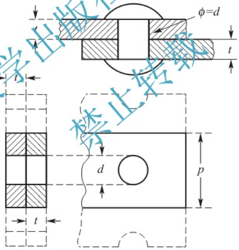


Fig. 12. 4 Principal dimensions of the simple riveted lap joint

$\sigma_t =$ tensile strength of plate material;

$\tau =$ shear strength of plate material;

$\gamma_c =$ crushing strength of plate material.

Hence for the single-riveted lap joint (Fig. 12. 4):

Smallest cross-sectional area of plate in tension $= (p-d) \cdot t$

∴Resistance of joint to tearing between holes $= \sigma_t (p-d)$ (1)

Cross-sectional area of rivet opposing shear $= \dfrac{\pi \cdot d^2}{4}$

∴Resistance of joint to shearing through a rivet $= \tau \cdot \dfrac{\pi d^2}{4}$ (2)

'projected area' of rivet $= t \cdot d$

∴Resistance of joint to crushing $= \sigma_c \cdot td$ (3)

It is desirable that the joint shall fail simultaneously by all three methods, viz. tearing of the plate between holes. Shearing of the rivets and crushing of the plate, then (1), (2) and (3) can be equated.

参考译文:

Reading 12　材料连接方法

大约在犬儒主义先驱戴奥真尼斯的木桶生活时代，一个名叫阿尔希塔斯的希腊人发明了螺丝。在公元前 2 世纪，希腊人将螺丝广泛用于榨酒机。同时，一种更为少见的用法是阿基米德将螺丝用于他的灌溉用水提升机。令人感到奇怪的是似乎没有人知道螺丝最初是作为夹紧装置使用的。

原始人类在连接材料方面经历了巨大困难。他们使用肌腱和皮条将他们棚屋的框架捆绑在一起，也用来连接和束缚石斧的头部。但是到公元前 3000 年，埃及的铜匠就可以制造钉子了，稍后，该地区的木工可以使用相当复杂的由动物胶粘合的六层胶合板。几乎可以确定，在公元前 3000 年铁匠史密斯已经掌握了使用铁锤和铁砧进行压力焊接的艺术，但是正如我们现在所知距离焊接技术的真正开始还不到一个世纪。

钉与螺栓连接

钉连接主要用于楼房结构建筑中的软木连接，由于木材具有相当强的弹性，其连接效果良好。驱动楔形物进入木材的钉子在钉子周围产生较大的弹性应变，而反过来这些弹性应变在钉子表面引起侧向压力，所产生的摩擦合力阻止钉子向外排出。

螺栓螺旋楔的作用可以产生更大的应变能量，所以螺栓连接点的效果更让人满意，这些在木材和螺栓之间产生的能量比木材和钉子之间的摩擦力大，此外，因为螺栓与木材之间相对摩擦的力只是那些零件的分离力，且它沿螺栓斜平面分解，所以分开此零件所需的作用力将是较大的。因此通过螺栓连接可以成功地将金属连接在一起。

铆钉连接

尽管作为连接材料方式的焊接得到越来越多使用，但铆接仍然是相当重要的，尤其是在造船和结构工程领域。学习过应用力学基础的大多数读者知道铆接设计需要使铆钉自身的强度和穿孔板的强度相等。

我们来看一个简单的铆钉搭接情况(图 12.2)。铆搭接可能以下面任何一种方式失效：

(i) 板材可能在铆钉下方裂开(W 处)。为防止出现该种类型的失败，通常要使从孔心到板边缘的距离不小于铆钉直径的 1.5 倍；

(ii) 板材可能在 X 点处“断裂”；

(iii) 如果铆钉孔之间的间距过近，其中的一块板可能沿 YZ 线撕裂；

(iv) 如果铆钉过小，它们可能沿 AB 线剪断。

为了以最经济的方式设计一个接头，其应当位于所有四种方式同时发生的失效点。搭接接头可以采用单排铆或双排铆(图 12.3)，但通常要使用多于两排的铆钉。节距指的是沿一排铆钉测量的铆钉中心之间的距离。接头强度可以考虑使用与节距等宽的金属板(图 12.4)来计算。

使　p＝铆钉节距；

d＝铆钉直径；

t＝板材厚度；

σ_t＝板材的抗拉强度；

τ＝板材的剪切强度；

γ_c＝板材的压碎强度。

由此，对于单排铆搭接接头(图 12.4)：

拉伸板最小横截面面积＝$(p-d)\cdot t$

所以，接头孔间的撕裂强度＝$\sigma_t(p-d)$　　(1)

铆钉抗剪切横截面＝$\pi\cdot d^2/4$

所以，铆钉接头抗剪切强度＝$\tau\pi d^2/4$　　(2)

铆钉的“投射面积”＝$t\cdot d$

压碎接头大间锥＝$\sigma_c\cdot td$　　(3)

需要注意的是，通过三种方法，即板材孔间撕裂、铆钉剪切以及板材压碎，连接头都将同时失效，于是公式(1)、(2)和(3)均相同。

Unit 13

Text 13: Tolerances, Limits and Fits

The basic or normal size of a component dimension is arrived at as a convenient size based on the design process. However, it is almost impossible to produce any component to the exact dimension through any of the known manufacturing processes. Even if a component is perceived to be made to the exact dimension by manual processes, the actual measurement with a high resolution measuring device will show that this is an incorrect perception.

It is therefore customary in engineering to allow a permissible deviation from the nominal size, which is termed as tolerance. Tolerance on a dimension can be specified in any of the two forms: unilateral or bilateral. In unilateral tolerance, the variation of the size will be wholly on one side. For example, $30^{+0}_{-0.01}$ is a unilateral tolerance. Here the dimension is allowed to vary between 30 and 29.99 mm.

In bilateral tolerance, the variation will be to both the sides. For example, 30.00 ± 0.02or $30.00^{+0.05}_{-0.1}$.

In bilateral tolerance, the variation of the limits can be uniform as shown in the former case. The dimension varies from 30.02mm to 29.98mm. Alternatively the allowed deviation can be different as shown in the second case. Here the dimension varies from 30.05mm to 29.90mm.

Sometimes the nominal size may be outside the allowable limits. For example, $29.95^{+0}_{-0.10}$or $30.00^{-0.05}_{-0.15}$ the dimension is to vary from 29.95mm to 29.85mm.

The second form is preferred since it contains the nominal size 30mm.

The dimensioning can also be specified in terms of the limits. For example, in the case of $30.00^{+0.05}_{-0.08}$, the upper limit is 30.05mm while the lower limit is 29.92mm. In the drafting practice, it is customary to show the dimension in any form. Some examples are shown in Fig. 13.1.

In engineering when a product is designed it consists of a number of parts and these

parts mate with each other in some form. In the assembly it is important to consider the type of mating or fit between two parts which will actually define the way the parts are to behave during the working of the assembly.

Take for example a shaft and hole, which will have to fit together. In the simplest case if the dimension of the shaft is lower than the dimension of the hole, then there will be clearance. Such a fit is termed clearance fit. Alternatively, if the dimension of the shaft is more than that of the hole, then it is termed interference fit. These are illustrated in Fig. 13. 2.

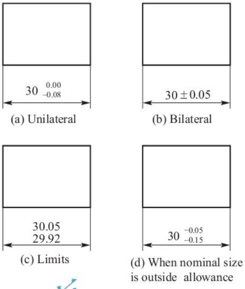


Fig. 13. 1 Typical tolerance specifications

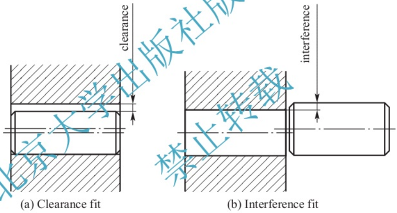


Fig. 13. 2 Typical fits possible in engineering assemblies

The situation will change further by adding the tolerances on the dimensions of the shaft and hole as shown in Fig. 13. 3.

In the case of Fig. 13. 3 (a), the maximum size of the shaft is smaller than the minimum hole and as a result, there will always be clearance with the clearance varying depending upon the actual sizes of the shaft and hole.

Maximum clearance = maximum limit size of hole − minimum limit size of shaft

Minimum clearance = minimum limit size of hole − maximum limit size of shaft

Such a fit is termed as clearance fit. Similarly in the case of Fig. 13. 3(b), there will be interference for all sizes. However in Fig. 13. 3(c), depending upon the possibilities of dimensions, at times there will be clearance and other times there will be interference. Such a fit is termed as transition fit.

Maximum clearance = Maximum limit size of hole − Minimum limit size of shaft

Maximum interference = Minimum limit size of hole − Maximum limit size of shaft

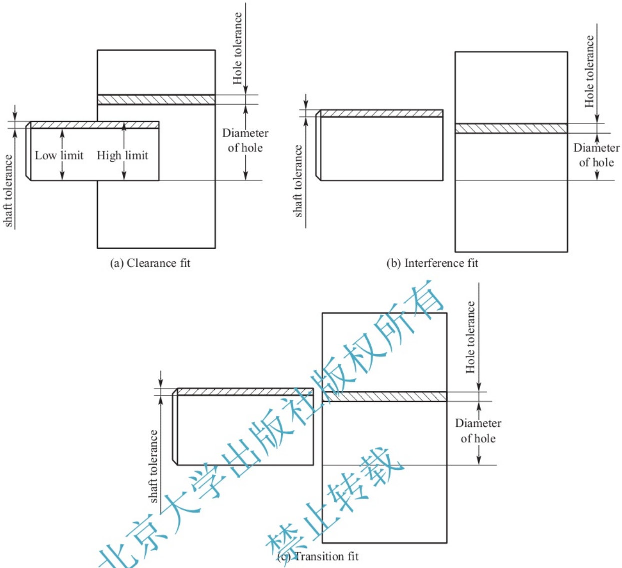


Fig. 13. 3　Three typical fits possible in engineering assemblies

Words and Expressions

1. tolerance [ˈtɔlərəns] *n.* 公差
2. limit [ˈlimit] *n.* 极限
3. fit [fit] *n.* 配合
4. nominal [ˈnɔminəl] *a.* ①基本的②标准的
5. dimension [diˈmenʃən] *n.* 尺寸，尺度
   v. 在…上标出尺寸
6. perceive [pəˈsiːv] *v.* ①察觉 ②感知，感到
7. perception [pəˈsepʃən] *n.* ①理解，概念 ②感知，感觉
8. measurement [ˈmeʒəmənt] *n.* ①尺寸 ②测量(法)
9. resolution [ˌrezəˈluːʃən] *n.* ①分辨率 ②坚定，决心
10. customary [ˈkʌstəmeri] *a.* 习惯的，惯例的
11. deviation [ˌdiːviˈeiʃən] *n.* 尺寸偏差

12. unilateral [ˈjuːniˈlætərəl] *a.* 单向的，单边的
13. bilateral [baiˈlætərəl] *a.* 有两边的，双向的
14. uniform [ˈjuːnifɔːm] *a.* 均匀的，一致的，统一的
 n. 制服
15. draft [dræft] *v.* 起草，设计
 n. 草案，草图
16. assembly [əˈsembli] *n.* ①装配 ②装配车间 ③组合件
17. mate [meit] *v.* 使配对，使一致
 n. 同伴，伙伴
18. shaft [ʃɑːft] *n.* 轴，转轴
19. clearance [ˈkliərəns] *n.* ①间隙，空隙 ②清扫，清楚
20. unilateral tolerance 单向公差
21. bilateral tolerance 双向公差
22. clearance fit 间隙配合
23. interference fit 过盈配合
24. transition fit 过渡配合

Notes

1. Even if a component is perceived to be made to the exact dimension by manual process, the actual measurement with a high resolution measuring device will show that this is an incorrect perception.

这是由 even if 引导的让步状语从句，从句中包含由 by 引导的方式状语，在主句中包含由 with 引导的方式状语，全句译为：尽管认为零件通过手工工艺加工可以达到精确尺寸，但是通过高精度测量装置的实际测量表明这是一个错误的认识。

2. In the assembly it is important to consider the type of mating or fit between two parts which will actually define the way the parts are to behave during the working of the assembly.

该句的主要结构是 It is＋形容词＋ to do sth。其中 it 是形式主语，to do sth. 是真正的主语。在“to consider…”中包含由 which 引导的定语从句修饰 parts，在 which 定语从句中又包含了一个 that 或 in which 引导的定语从句修饰 the way，在该句中 that 或 in which 被省略了。全句译为：在装配中，考虑两个零件之间组合或配合的类型是重要的。实际上，这种组合或配合将决定在装配生产中零件运转的方式。

Word-Study

Ⅰ. *Base, Basis, Basic*

1. The machine must rest on a firm base. It must be firmly based.
2. He reached this conclusion on the basis of experimental data.

3. The thermostat is based on the fact that different metals have different coefficients of expansion.

4. The basic law in electric circuit theory is Ohm's law.

Ⅱ. *Device, Instrument, Apparatus*

Note: a) A device is usually a clever mechanism which is devised or invented to solve some particular mechanical problem. b) An instrument is usually a small manufactured object which enables us to perform some precise action or measurement. c) An apparatus is usually a complicated mechanism or assembly of many different pieces used for some scientific experiment or test.

1. A thermostat is a device for regulating temperatures.
2. A pyrometer is an instrument for measuring high temperature.
3. A bomb calorimeter is an apparatus for finding out the calorific value of a solid or liquid fuel.

Sentence Patterns

Ⅰ. Means

a) by+ n. / doing	b) by means of
c) with	d) with the help of

1. The road was cleared by (means of) a bulldozer.
   =The road was cleared with (the help of) a bulldozer.
2. Heat losses can be reduced by firebricks.
   =We can reduce heat losses by the use of firebricks.
   =We can reduce heat losses by lining the furnace with firebricks.
3. This can be done by means of firebricks.
4. By lining the furnace with firebricks, heat losses can be reduced.

Ⅱ. Result

<table>
<tr><td>1.</td><td>The temperature of the gas rises.</td><td rowspan="3">Therefore,
Consequently,
Hence,
Thus,
As a result,</td><td>it expands in the cylinder.</td></tr>
<tr><td>2.</td><td>After-burners have to be used.</td><td>fuel consumption is heavier.</td></tr>
<tr><td>3.</td><td>The aircraft speed is limited.</td><td>it will soon become obsolete.</td></tr>
</table>

<table>
<tr><td>4.</td><td>The temperature of the gas rises,</td><td rowspan="3">so that
with the result that</td><td>it expands in the cylinder.</td></tr>
<tr><td>5.</td><td>After-burners have to be used,</td><td>fuel consumption is heavier.</td></tr>
<tr><td>6.</td><td>The aircraft speed is limited,</td><td>it will soon become obsolete.</td></tr>
</table>

7.	A rise in the temperature of the gas	results in leads to	its expansion.
8.	The use of after-burners		increased fuel consumption

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is a convenient size based on?
2. Is it possible to produce any component to the exact dimension through the known manufacturing process?
3. What are the forms of tolerance on a dimension?
4. What is the feature of unilateral tolerance?
5. What is the feature of bilateral tolerance?

Ⅱ. Match the items listed in the following two columns.

Column A	**Column B**
1. ( ) dimension	A) 轴
2. ( ) assembly	B) 单向公差
3. ( ) deviation	C) 尺寸
4. ( ) shaft	D) 过渡配合
5. ( ) unilateral tolerance	E) 尺寸偏差
6. ( ) transition fit	F) 双向公差
7. ( ) bilateral tolerance	G) 装配

Ⅲ. Join the two statements in each line, by using *by*, *by means of*, or *with*.

1. Production can be greatly increased ________ the introduction of new machinery.
2. We can prevent oxidation of the metal ________ a flux.
3. Rapid heating in the boiler is achieved ________ forced circulation.
4. The work is firmly held in the lathe ________ the centers.
5. Better combustion is obtained ________ a hemispherical combustion chamber.
6. The heat-resistant properties of the steel can be improved ________ the addition of chromium and nickel.
7. Frequent measurements of the bar were made ________ a micrometer.
8. The temperature of the liquid is raised ________ the application of heat.
9. Greater needs can now be attained by modern aircraft ________ the new metals which are now being developed.
10. More rapid burning is made possible ________ the use of pulverized fuels.

Ⅳ. Fill in each of the blanks in the following sentences with *base*, *basis* or basic. Change the forms where necessary.

1. There is no factual ________ for this theory.

2. Nimonic alloys are alloys with a nickel ________ . It is a nickel - ________ alloy.
3. The synchroscope is ________ on the principle of the rotating field.
4. The ________ training for workers is to learn those instructions of the NC machine.
5. The ________ of common logarithms is 10.

Reading 13: Manufacturing Process

An extensive and continuously expanding variety of manufacturing processes are used to produce parts and there is usually more than one method of manufacturing a part from a given material.

(a) Casting: Die casting, gravity casting, precision casting and sand casting.

(b) Forming and shaping: Rolling, forging, extrusion, drawing, sheet forming, powder metallurgy.

(c) Machining: Turning, boring, drilling, milling, planing, shaping, broaching, and grinding, ultrasonic machining; chemical, electrical, and electrochemical machining; and micromachining for producing ultra - precision parts.

(d) Joining: Welding, brazing, soldering, diffusion bonding, adhesive bonding, and mechanical joining.

(e) Finishing: Honing, lapping, polishing, burnishing, deburring, surface treating, coating, and plating.

(f) Nanofabrication: It is the most advanced technology and is capable of producing parts with dimensions at the nano level (one billionth); it typically involves processes such as etching techniques, electron - beams, and laser - beams. Present applications are in the fabrication of microelectromechanical systems (MEMS) and extending to nanoelectromechanical systems (NEMS), which operate on the same scale as biological molecules.

Selection of a particular manufacturing process, or a sequence of processes, depends not only on the shape to be produced but also on other factors pertaining to material properties. As examples, brittle and hard materials cannot be shaped or formed easily, whereas they can be cast machined, or ground. Metals that are previously formed at room temperature become stronger and less ductile than they were before processing them, and thus will require higher forces and be less formable during subsequent (secondary) processing.

As described throughout this text, each manufacturing process has its own advantages and limitations, as well as production rates and product cost. Manufacturing engineers constantly are being challenged to find new solutions to manufacturing problems and cost reduction. For example, sheet metal parts traditionally have been cut and fabricated using common mechanical tools, punches, and dies. Although still widely used, some of these operations are being replaced by laser - cutting techniques in which the path of the laser can be controlled, thus increasing the capability for producing a wide variety of shapes accurately, and economically, as well as eliminating the need for punches and dies.

With advances in all aspects of materials, processes, and production control, there have been certain important trends in manufacturing, as briefly outlined below.

Materials and processes: The trend is for better control of material compositions, purity, and defects (impurities, flaws) in order to enhance their overall properties, manufacturing characteristics, reliability, service life, and recycling, while keeping material costs low. Developments are continuing on superconductors, semiconductors, nanomaterials, nanopowders, and coatings. Testing methods and equipment are being improved, including use of advanced computers and software, particularly for materials such as ceramics, carbides, and composites.

Concerns over material and energy savings have lead to better recyclability, as well as weight savings by improving design and engineering considerations, such as higher strength-to-weight and stiffness-to-weight ratios. Surface treatment methods are being advanced rapidly. Included in these developments are advances in tool, die, and mold materials to improve their performance. The recent developments in processing involve ultraprecision, micro, and nanomanufacturing, approaching atomic levels.

Computer simulation and modeling continue to be used widely in design and manufacturing, resulting in the optimization of processes and production systems, and better prediction of the effects of relevant variables on product integrity. As a result of such efforts, the speed and efficiency of product design and manufacturing is improving greatly, also affecting the overall economics of production and reducing product cost in an increasingly competitive and global marketplace.

参考译文:

Reading 13　制 造 工 艺

制造工艺技术不断发展变化，被广泛应用于生产零件上。对于同一种材料，通常有多种制造零件的方法。

（1）铸造：压铸、重力铸造、精密铸造、砂型铸造。

（2）成形和造型：滚压，锻造，挤压，拉拔，钣金成形，粉末冶金。

（3）机械加工：车削加工，镗削加工，钻削加工，铣削加工，刨削加工，成形加工，拉削加工，磨削加工，超声波加工；化学加工，电加工；以及显微机械加工，用于生产超精密零件。

（4）连接：焊接，钎焊，锡焊，扩散焊接，粘接和机械连接。

（5）精加工：珩磨，研磨，抛光，打磨，去毛刺，表面处理，涂料和电镀。

（6）纳米技术：它是目前最先进的技术，能够生产纳米级尺寸的零件。典型的纳米技术包括蚀刻技术、电子束和激光束。目前应用于微机电系统制造并扩展至纳米机电系统，这个纳米机电体系具有同生物分子相同的作用。

选择一个具体的制造工艺或加工顺序，不仅取决于要制造的零件形状，还取决于其他

关于材料性能方面的因素。例如，脆性和坚硬的材料不易造型，但它们可以经过铸造、加工或打磨而成。另外，在室温下加工来的金属会变得更加坚硬且不易变形，因此若要进行二次加工，则需要更大的外力，并且在以后的加工中不易变形。

正如本文所描述的，每种制造工艺都有其自身的优点和局限性，类似于生产率和生产成本。制造工程师们正不断尝试寻找解决工艺问题和降低成本的新方法。例如，传统上使用普通的机械刀具、冲床和冲模对薄钢板零件进行切割和制造。尽管其仍被广泛使用，但其中的一些操作方法正在被激光切割技术所取代。在激光切割技术中，激光的路径能够被控制，因此使得更精确地、经济地生产不同形状零件的可能性增大，并且减少了冲床和冲模的使用。

随着材料、加工工艺和生产管理等方面的进步，在制造业中出现了一些重要的趋势，简述如下。

材料和加工：将能对材料成分、纯度和缺陷(杂质、夹杂物、裂纹)进行更好的控制，以增强整体的性能、制造特点、可靠性、使用寿命和循环性，同时保证较低的材料成本。超导体、半导体、纳米材料、纳米粉末和涂料业也将得到进一步发展。检测方法和仪器也正在改进中，包括高级计算机和软件的使用，尤其是针对陶瓷、碳化物和复合物等材料。

对材料和节能的关注，通过改进设计和工程节省重量，如考虑较高的强度重量比和刚度重量比，会具有更好的循环性。其中刀具、冲模和模型材料也得到一定发展来改进它们的性能。目前发展加工技术的需求包括超精度、微加工和纳米加工，都达到了原子级别。

计算机模拟和建模被持续广泛应用于设计和制造中，使工艺和生产系统得以最优化并对产品优化的相关变量效应做出更好的预测。这些发展使产品设计和制造的速度和效率有了很大的改进，也影响了生产总体的经济状况，同时也减少了在竞争力不断增加的全球市场中的产品成本。

Unit 14

Text 14: Properties of Materials

Machine elements are very often made from one of the metals or metal alloys such as steel, aluminum, cast iron, zinc, titanium, or bronze. This section describes the important properties of materials as they affect mechanical design.

Strength, elastic, and ductility properties for metals, plastics, and other types of materials are usually determined from a tensile test in which a sample of the material, typically in the form of a round or flat bar, is clamped between jaws and pulled slowly until it breaks in tension[2]. The magnitude of the force on the bar and the corresponding change in length (strain) are monitored and recorded continuously during the test. Because the stress in the bar is equal to the applied force divided by the area, stress is proportional to the applied force[3]. The data from such tensile tests are often shown on stress-strain diagrams, such as those shown in Fig. 14. 1 and Fig. 14. 2. in the following paragraphs, several strength, elastic, and ductility properties of metals are defined.

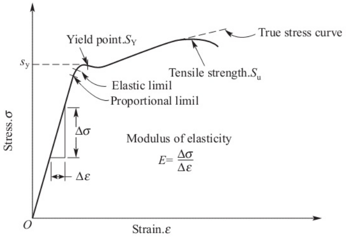


Fig. 14. 1 Typical stress-strain diagram for steel

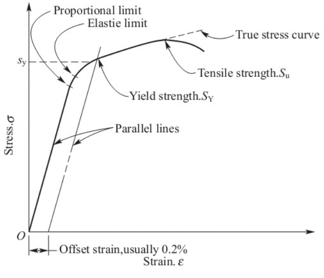


Fig. 14. 2 Typical stress-strain diagram for aluminum and other metals having no yield point

Tensile strength, S_u

The peak of the stress - strain curve is considered the ultimate tensile strength (S_u), sometimes called the ultimate strength or simply the tensile strength. At this point during the test, the highest apparent stress on a test bar of the material is measured. As shown in Fig. 14. 1 and Fig. 14. 2, the curve appears to drop off after the peak.

Yield strength, S_Y

That portion of the stress - strain diagram where there is a large increase in strain with little or no increase in stress is called the yield strength (S_Y). This property indicates that the material has, in fact, yielded or elongated plastically, permanently, and to a large degree[4]. If the point of yielding is quite noticeable, as it is in Fig. 14. 1, the property is called the yield point rather than the yield strength. This is typical of a plain carbon hot rolled steel.

Fig. 14. 2 shows the stress - strain diagram form that is typical of a nonferrous metal such as aluminum or titanium or of certain high - strength steels. Notice that there is no pronounced yield point, but the material has actually yielded at or near the stress level indicated as S_Y[5]. That point is determined by the offset method, in which a line is drawn parallel to the straight - line portion of the curve and is offset to the right by a set amount, usually 0. 20% strain (0. 002 mm/mm). The intersection of this line and the stress - strain curve defines the material's yield strength. In this book, the term yield strength will be used for S_Y, regardless of whether the material exhibits a true yield point or whether the offset method is used[6].

Proportional limit

That point on the stress - strain curve where it deviates from a straight line is called the proportional limit. That is, at or above that stress value, stress is no longer proportional to strain. Below the proportional limit, Hooke's law applies: Stress is proportional to strain. In mechanical design, materials are rarely used at stresses above the proportional limit.

Elastic limit

At some point, called the elastic limit, a material experiences some amount of plastic strain and thus will not return to its original shape after release of the load. Below that level, the material behaves completely elastically. The proportional limit and the elastic limit lie quite close to the yield strength. Because they are difficult to determine, they are rarely reported.

Modulus of elasticity in Tension, E

For the part of the stress - strain diagram that is straight, stress is proportional to strain, and the value of E, the modulus of elasticity, is the constant of proportionality[7]. That is,

$$E=\frac{\text{stress}}{\text{strain}}=\frac{\sigma}{\varepsilon} \tag{14. 1}$$

This is the slope of the straight - line portion of the diagram. The modulus of elasticity indicates the stiffness of the material, or its resistance to deformation.

Words and Expressions

1. zinc [ziŋk] *n.* ①锌 ②(电池中的)锌片
   v. 镀锌于，用锌处理
2. titanium [tai'teini:əm] *n.* 钛
3. elastic [i'læstik] *a.* ①有弹性的，有弹力的 ②可伸缩的，灵活的
   elastic limit 弹力极限(固体可以拉深而不致使尺寸和形状永久变形的最大长度)
   elastic modulus 弹力系数(致使物体变形的力的比率)
   elasticity [ˌi:læ'stisiti] *n.* ①弹性，弹力 ②伸缩性，灵活性
4. ductility [dʌk'tiliti] *n.* ①延性，可延展性，可锻性
5. clamp [klæmp] *v.* ①(用夹具等)夹紧，夹住，固定 ②紧紧抓住，牢牢控制
6. jaw [dʒɔ:] *n.* ①钳口 ②下颌，下巴
7. tensile ['tensəl] *a.* 张力的，拉力的，抗张的
   tensile strength 抗拉强度，拉深强度
   tensile stress (抗)张应力，拉(深)应力
8. tension ['tenʃən] *n.* ①张力，拉力 ②拉紧，绷紧，拉紧状态(程度)
   tension test 拉力试验
9. magnitude ['mægnitju:d] *n.* ①量，量值，强度，长度 ②重要性，重大，庞大，广大
10. monitor ['mɔnitə] *v.* 监视，检测，监督，监控
    n. ①(校的)班长，级长 ②监控器
11. proportional [prə'pɔ:ʃənəl] *a.* ①均衡的，相称的 ②比例的，成比例的
    be proportional to 与…成比例
    proportionality [prəˌpɔ:ʃən'æliti] *n.* 比例(性)，均衡(性)，相称
12. yield [ji:ld] *v.* ①屈服，顺从 ②出产，产出
    yield strength 屈服强度
    yield stress 屈服应力
13. elongate [i'lɔ:ŋgeit] *v.* 拉长，使伸长，使延长
    elongation [ˌilɔ:ŋ'geiʃən] *n.* ①延伸率 ②伸长，延长，拉长(物、部分)
14. nonferrous ['nɔn'ferəs] *a.* ①不含铁的，非铁制的 ②非铁的
15. pronounced [prə'naʊnst] *a.* ①显著的，明显的 ②明确的，断然的
16. offset ['ɔfset] *a.* ①补偿的 ②偏(离中)心的，偏置的

17. intersection [intə'sekʃən] n. ①横断，交叉 ②交点，十字路口
18. modulus ['mɔdjuləs] n. ①模量，系数 ②标准，准则
19. slope [sləup] n. ①斜线，斜面 ②斜率；③斜坡
v. 使倾斜
20. deformation [di:fɔ:'meiʃən] n. 损形，变丑，畸形，变形
21. stiffness ['stifnis] n. 僵硬，硬度，不易弯曲性

Notes

1. 本篇课文语法现象重点：

1）被动语态在科技文章中的应用。科技文章为避免主观性过强，说理过于肤浅，为使表达内容更加正式，更加客观，同时也更具说服力，所以大量使用不明显的被动语态。本文便是体现被动语态在科技文章中重要性的典型代表，通篇被动语态使用频率达18次之多。

2）过去分词或过去分词短语做定语。动词有不定式、现在分词和过去分词三种非动词形式，其中经常用做形容词来修饰名词的有现在分词和过去分词两种，现在分词多做前置定语，而过去分词多做后置定语，当然有时也直接放在被修饰词前做定语。

2. Strength, elastic, and ductility properties for metals, plastics, and other types of materials are usually determined from a tensile test in which a sample of the material, typically in the form of a round or flat bar, is clamped between jaws and pulled slowly until it breaks in tension.

本句为复杂复合句。Until 之后为其引导的时间状语从句，之前为主句；主句中包含一个定语从句，先行词为 a tensile test，引导词 which 之前的 in 与 a tensile test 构成搭配。prep. + which clause 是本课重点。本句可译为：金属、塑料以及其他材料的强度、弹性和延展性往往通过拉深试验来测定。试验中，先将圆棒形或扁棒形试件夹在夹头之间，而后加载并慢慢拉深直至试件断裂。

3. Because the stress in the bar is equal to the applied force divided by the area, stress is proportional to the applied force.

本句主句为 stress is proportional to the applied force，其中短语 be proportional to 在本课中出现频率较高，意思是“与…成比例”，从句为 because 引导的原因状语从句，从句中 divided by the area 为过去分词短语做后置定语。本句可译为：因为应力等于试验力与面积之比，所以应力与试验力成比例。

4. This property indicates that the material has, in fact, yielded or elongated plastically, permanently, and to a large degree.

本句为一简单复合句，其中只有一个 that 引导的从句做 indicate 的宾语。值得注意的是：in fact 此处是插入语，其位置也可换至句首和句尾；而 plastically, permanently 和 to a large degree 三者为并列关系。本句可译为：事实上，屈服特性表明材料在很大程度上已发生永久塑性变形。

5. Notice that there is no pronounced yield point, but the material has actually yielded at or near the stress level indicated as S_Y.

本句为由表示语义转折的连词 but 连接的并列句。前一分句中又包含一个 that 引导的从句做 notice 的宾语；后一分句中 indicated as S_Y 为过去分词短语做后置定语。本句可译为：我们没有发现明显屈服点，但实际上材料已经变形或接近 S_Y 所示的应力水平。

6. In this book, the term yield strength will be used for S_Y, regardless of whether the material exhibits a true yield point or whether the offset method is used.

本句中短语 regardless of 意为“不论、不顾、不计”，其后接两个 whether 引导的名词性从句做宾语，两 whether 从句之间由 or 连接，体现其并列关系；整个 regardless of whether the material exhibits a true yield point or whether the offset method is used 部分在全句中只是一个让步状语的成分。本句可译为：本书中，术语屈服强度用字母 S_Y 表示，不论材料是否显现其真正的屈服点或是否使用偏移测定法。

7. For the part of the stress－strain diagram that is straight, stress is proportional to strain, and the value of E, the modulus of elasticity, is the constant of proportionality.

本句为 and 引导的并列句，其中做状语的部分里又包括一个 that 引导的定语从句修饰 the part of the stress－strain diagram, the modulus of elasticity 为 the value of E 的同位语，起解释说明的作用。本句可译为：对于应力应变曲线图上的直线部分来说，应力与应变成比例。E 值、弹性模量为比例系数。

Word-Study

Property, Feature, Characteristic, Peculiarity, Trait, Attribute, Character

property：多指同类事物共有的特性，一般不用于指人。
feature：指事物突出引人注目的特点。多用来说明人的容貌特征或地理特征。
characteristic：指某人或某物天生有别于他人或他物的内部特质或外表特征。
peculiarity：指人或事物独具的或奇怪的特点，常带感情色彩。
trait：多指人的性格、心情的特征，尤指先天的持久的行为模式或性格特征。
attribute：通常指人主观赋予某事物的属性，可指典型事物。
character：多指一类人或事物所具有的独特的典型的特征。

Sentence Patterns

Ⅰ. prep. ＋which

e. g. Strength, elastic, and ductility properties for metals, plastics, and other types of materials are usually determined from a tensile test in which a sample of the material, typically in the form of a round or flat bar, is clamped between jaws and pulled slowly until it breaks in tension.

e. g. That point is determined by the offset method, in which a line is drawn parallel to the straight－line portion of the curve and is offset to the right by a set amount, usually 0.20% strain (0.002mm/mm).

Ⅱ. be+adj. +to

Happiness	be	is not	proportional to	virtue sometimes.
Salary		is		years of experience.
Sentence		should be		the crime.
Salary raises		were		the cost of living.
One horse	be	is not	equal to	pulling a load of 5 tons.
One unit of alcohol		is		half a pint of beer.
He		may be		the challenge.
These jobs		are		their abilities.
The road	be	is not	parallel to	the river.
The lane		is		the main road roughly.
The highway		was		the old country road for a few miles.
The road and the canal		are		each other.

Exercises

Ⅰ. Fill in the following blanks by using "prep. +which" pattern.

1. America is the country ________ George Washington was born.
2. I have forgotten the exact date ________ this small country became independent.
3. In the office I never seem to have time until after 5 : 30 p. m. ________ many people have got home.
4. The reason ________ he refused to go to the party was that they had not invited him to.
5. The speed ________ the car runs depends on the road condition.
6. The instrument ________ the temperature is measured is called thermometer.

Ⅱ. Give brief answers to the following questions.

1. How could we determine the strength, elastic and ductility properties of materials?
2. Why the magnitude of the force on the bar and the corresponding change in length are monitored and recorded continuously during the test?
3. Which part of the stress - strain curve is called the tensile strength?
4. What is yield strength?
5. Under what circumstances could we call the property the yield point rather than the yield strength?
6. How could we determine the yield point by the offset method?
7. Why the proportional limit and the elastic limit are rarely reported?
8. What does the modulus of elasticity indicate?

Ⅲ. Decide the following sentences are true (T) or false (F) according to the information you got from the passage.

1. In a tensile test, the sample of the material is clamped between jaws and pulled

quickly until it breaks in tension. (　　)

2. The magnitude of the force on the bar and the corresponding change in length are monitored and recorded occasionally during the test. (　　)
3. The highest point of the stress – strain curve is considered the ultimate tensile strength. (　　)
4. In mechanical design, materials are commonly used at stresses above the proportional limit. (　　)
5. The material behaves completely elastically below the elastic limit. (　　)

Ⅳ. Fill in the blanks with the words given below. Change the form where necessary.

tension	intersection	slope	proportional	pronounced	yield	monitor	offset

1. The newly built radar station is used to ________ heavy bombers.
2. The dwarf's long arms were not ________ to his height.
3. The support should not ________ to every demand that the television company make.
4. Every Chinese farmer could notice a ________ contrast between the past and the present.
5. Bridges are used to avoid the ________ of a railroad and a highway.
6. The second row of seats was slightly ________ to one side.
7. The mountain path is with a ________ of 30 degrees.
8. Measures are needed to reduce ________ between the two states.

Ⅴ. Match the items listed in the following two columns.

Column A	Column B
1. (　　) pronounced	A) a quality or feature of something
2. (　　) yield	B) the ability of a substance to stretch and then return to its original shape
3. (　　) elongate	C) to put or hold something firmly in position
4. (　　) monitor	D) able to be stretched
5. (　　) property	E) to become longer or make something longer
6. (　　) tensile	F) very obvious or noticeable
7. (　　) elasticity	G) to move or bend when you push or pull it
8. (　　) clamp	H) to regularly check something in order to find out what's happening

Ⅵ. Fill in the blanks with the words mentioned in Word Study part.

1. Each city has its own ________, its own history and character.
2. The little boy is searching for a herb with healing ________ .
3. The furniture in Tom's apartment was pretentious and without ________ .
4. The capacity to think is the distinctive ________ of our species.
5. Her generosity is one of her most pleasing ________ .
6. The island's chief ________ was its beauty.

7. Courage is a(n)________ of a good soldier.

Reading 14: Ductility and percent elongation

Ductility is the degree to which a material will deform before ultimate fracture. The opposite of ductility is brittleness. When ductile materials are used in machine members, impending failure is detected easily, and sudden failure is unlikely. Also, ductile materials normally resist the repeated loads on machine elements better than brittle materials.

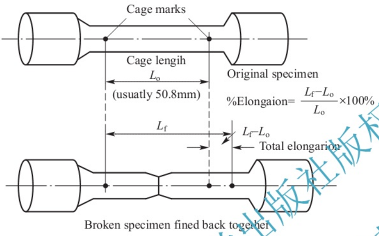


Fig. 14. 3 Measurement of percent elongation

The usual measure of ductility is the percent elongation of the material after fracture in a standard tensile test. Fig. 14. 3 shows a typical standard tensile specimen before and after the test. Before the test, gage marks are placed on the bar, usually 50. 8 mm apart. Then, after the bar is broken, the two parts are fitted back together, and the final length between the gage marks is measured. The percent elongation is the difference between the final length and the original length divided by the original length, converted to a percentage. That is,

$$\text{percent elongation}=\frac{L_f-L_o}{L_o}\times100\% \tag{14. 2}$$

Percent elongation

The percent elongation is assumed to be based on a gage length of 50. 8 mm in unless some other gage length is specifically indicated. Tests of structural steels often use a gage length of 203. 2 mm. Theoretically, a material is considered ductile if its percent elongation is greater than 5%(lower values indicate brittleness). For practical reasons, it is advisable to use a material with a value of 12% or higher for machine members subject to repeated loads or shock or impact. Percent reduction in area is another indication of ductility. To find this value, compare the original cross - sectional area with the final area at the break for the tensile test specimen.

Shear strength, s_{ys} and s_{us}

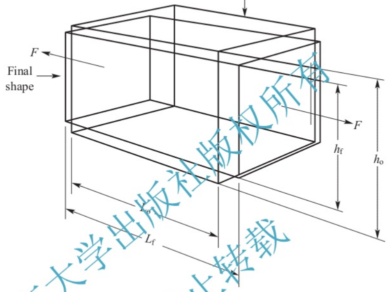
Both the yield strength and the ultimate strength in shear (s_{ys} and s_{us} respectively) are important properties of materials. Unfortunately, these values are seldom reported. We will use the following estimates:

$$s_{ys}=s_y/2=0.50s_y=\text{yield strength in shear} \tag{14. 3}$$

$$s_{us}=0.75s_u=\text{ultimate strength in shear} \tag{14. 4}$$

Poisson's ratio, μ

When a material is subjected to a tensile strain, there is a simultaneous shortening of the cross - sectional dimensions perpendicular to the direction of the tensile strain. The ratio of the shortening strain to the tensile strain is called Poisson's ratio, usually denoted by μ, the Greek letter nu(the Greek letter mu, u, is sometimes used for this ratio). Poisson's ratio is illustrated in Fig. 14. 4. typical ranges of values for poisson's ratio are 0. 25～0. 27 for cast iron, 0. 27～0. 30 for steel, and 0. 30～0. 33 for aluminum and titanium.



$$\text{Axial strain}=\frac{L_f-L_o}{L_o}=\varepsilon_e$$

$$\text{Lateral strain}=\frac{h_f-h_o}{L_o}=\varepsilon_L$$

$$\text{Poisson's ratio}=\frac{-\varepsilon_L}{\varepsilon_e}=\mu$$

Fig. 14. 4 Illustration of Poisson's ratio for an element in tension

Modulus of elasticity in shear, *G*

The modulus of elasticity in shear (G) is the ratio of shearing stress to shearing strain. This property indicates a material's stiffness under shear loading - that is, the resistance to shear deformation. There is a simple relationship between E, G, and Poisson's ratio:

$$G=\frac{E}{2(1+\mu)} \tag{14.5}$$

This equation is valid within the elastic range of the material.

Flexural modulus

Another stiffness measure often reported, particularly for plastics, is called the flexural modulus, or modulus of elasticity in flexure. As the name implies, a specimen of the material is loaded as a beam in flexure (bending) with data taken and plotted for load ver-

sus deflection. From these data and from knowledge of the geometry of the specimen, stress and strain can be computed. The ratio of stress to strain is a measure of the flexural modulus. ASTM standard D 790' defines the complete method. Note that the values are significantly different from the tensile modulus because the stress pattern in the specimen is a combination of tension and compression. The data are useful for comparing the stiffness of different materials when a load-carrying part is subjected to bending in service.

参考译文：

Reading 14　韧性与延伸率

韧性是指材料在最终断裂前发生变形的程度。与韧性相对的是脆性。韧性材料用于机器零件时，容易检测到即将发生的断裂，却未必可能发生突然断裂。并且，与脆性材料相比，韧性材料更适用于承受重复加载的机械零件。

韧性的测量度通常是采用材料在标准拉深试验中发生断裂后的延伸率。图 14.3 是一典型标准拉深试件在试验前后的对比图。试验前，在试件上标上标线，标线间距通常为 50.8mm。然后加载至试件断裂，将两部分重新对接一起，然后测得最终标线间距。最终长度与初始长度之差与初始长度的比值转化成百分比后即可得出延伸率。

延伸率

延伸率是在标线间距假定为 50.8mm 基础上测得的，除非对标线间距另作规定。测试结构钢的延伸率时，标线间距常为 203.2mm。理论上讲，如果材料的延伸率大于 5%（低于此值表示脆性），那么该材料为韧性材料。基于现实原因，常常受到重复加载、振动或冲击的机器零件，使用延伸率等于或大于 12%的材料是合理的。截面收缩率是韧性的另一指标。为测得此值，将起始横截面面积与拉深试件的最终断面面积相比较。

剪切强度，s_{ys}与 s_{us}

剪切中的屈服强度和极限强度是(分别指 s_{ys} 和 s_{us})材料的重要特性，很遗憾，这些数值却很少被报告。我们将利用如下估计值：

泊松比，μ

当材料受到拉深应变时，垂直于拉深应变方向的横断面尺寸将会及时变小。拉伸应变量与收缩应变量的比值称为泊松比，通常用符号 μ，希腊字母 nu 表示(希腊字母 mu，u 有时也被用作表示泊松比)，泊松比如图 14.4 所示。铸铁、钢以及铝和钛的典型泊松比值范围常分别是，铸铁 0.25～0.27、钢 0.27～0.30 及铝和钛 0.30～0.33。

剪切弹性模量，G

剪切弹性模量是指剪切应力与剪切应变之比。这种特性表明材料在剪切载荷下的刚度——即：剪切变形的抵抗能力，抗拉弹性模量 E，剪切弹性模量 G 和泊松比之间的简单关系式如下：

$$G=\frac{E}{2(1+\mu)} \tag{14-5}$$

该等式在材料弹性范围内有效。

弯曲模量

另一刚性量度——弯曲模量经常被报道，尤其对塑料而言。顾名思义，某材料试件作为一搭曲梁(弯曲)，用所取数据对其加载，并绘制载荷与偏转的曲线图。根据这些数据以及试件的几何固形知识，计算出应力和应变。应力与应变之比是弯曲模量的一个量度。美国材料与试验协会(ASTM)D 790 标准对完整测定方法做了定义。注意：测得数值与拉深模量截然不同，因为此时的试件应力模式为一拉深与压缩的组合。受力零件在发生工作弯曲时，该数值益于比较不同材料的刚度。

Unit 15

Text 15: Shaft Design Procedure

The specific tasks to be performed in the design and analysis of a shaft depend on the shaft's proposed design in addition to the manner of loading and support. With this in mind, the following is a recommended procedure for the design of a shaft.

1. Determine the rotational speed of the shaft.

2. Determine the power or the torque to be transmitted by the shaft.

3. Determine the design of the power-transmitting components or other devices that will be mounted on the shaft, and specify the required location of each device.

4. Specify the location of bearings to support the shaft. Normally two and only two bearings are used to support a shaft. The reactions on bearings supporting radial loads are assumed to act at the midpoint of the bearings. For example, if a single-row ball bearing is used, the load path is assumed to pass directly through the balls. If axial loads exist in the shaft, you must specify which bearing is to be designed to react against the thrust load. Then the bearing that does not resist the thrust should be permitted to move slightly in the axial direction to ensure that no unexpected and undesirable thrust load is exerted on that bearing.

Bearings should be placed on either side of the power-transmitting elements if possible to provide stable support for the shaft and to produce reasonably well-balanced loading of the bearings. The bearings should be placed close to the power-transmitting elements to minimize bending moments. Also, the overall length of the shaft should be kept small to keep deflections at reasonable levels.

5. Propose the general form of the geometry for the shaft, considering how each element on the shaft will be held in position axially and how power transmission from each element to the shaft is to take place.

How will the bearings and the gears be located so as to ensure that they stay in position during operation, handling, shipping, and so forth? Of course, there are many ways to do this. Shoulders are to be machined in the shaft to provide surfaces against which to

seat the bearings and the gears on one side of each element. The gears are restrained on the other side by retaining rings snapped into grooves in the shaft. The bearings will be held in position by the housing acting on the outer races of the bearings. Keyseats will be machined in the shaft at the location of each gear. This proposed geometry provides for positive location of each element.

6. Determine the magnitude of torque.

7. Determine the forces that are exerted on the shaft, both radially and axially.

8. Resolve the radial forces into components in perpendicular directions, usually vertically and horizontally.

9. Solve for the reactions on all support bearings in each plane.

10. Produce the complete shearing force and bending moment diagrams to determine the distribution of bending moments in the shaft.

11. Select the material from which the shaft will be made, and specify its condition cold-drawn, heat-treated, and so on. Plain carbon or alloy steels with medium carbon content are typical, such as AISI 1040, 4140, 4340, 4640, 5150, 6150, and 8650. Determine the ultimate strength, yield strength, and percent elongation of the selected material.

12. Determine an appropriate design stress, considering the manner of loading (smooth, shock, repeated, or other).

13. Analyze each critical point of the shaft to determine the minimum acceptable diameter of the shaft at that point in order to ensure safety under the loading at that point. In general, the critical points are several and include those where a change of diameter takes place, where the higher values of torque and bending moment occur, and where stress concentrations occur.

14. Specify the final dimensions for each point on the shaft. Normally, the results from Step 13 are used as a guide, and convenient values are then chosen. Design details such as tolerances, fillet radii, shoulder heights, and keyseat dimensions must also be specified. Sometimes the size and the tolerance for a shaft diameter are dictated by the element to be mounted there.

Words and Expressions

1. specific	[spi'sifik]	*a.*	特殊的，特定的
		n.	①特性
			②特效药
2. perform	[pə'fɔːm]	*v.*	履行，执行
		v.	(机器)运转，(人)行动，表现
3. propose	[prə'pəuz]	*v.*	①提议，建议，提出
			②提议祝(酒)，提议为…干杯

4. procedure [prə'si:dʒə] *n.* 程序，手续，步骤
5. rotational [rəu'teiʃənəl] *a.* 循环的，回转的，轮流的
6. torque [tɔ:k] *n.* 转矩
7. transmit [træns'mit] *v.* 传送，传达
8. mount [maunt] *v.* 登上，爬上，骑上，骑在…上
   n. 安装，固定
9. reaction [ri'ækʃən] *n.* ①反应，感应
   ②反作用，反作用力
10. axial ['æksiəl] *a.* 轴的
11. resist [ri'zist] *v.* 抵抗，反抗，抗拒
   n. ①抗蚀护膜
   ②阻膜，阻剂
12. exert [ig'zə:t] *v.* ①用(力)，尽(力)
   ②运用，行使，发挥，施加
13. minimize ['minəmaiz] *v.* 使减到最少，使缩到最小
14. moment ['məumənt] *n.* 力矩
15. deflection [di'flekʃən] *n.* 挠曲度
16. transmission [træns'miʃən] *n.* ①传送，传达
   ②传动装置，变速器
17. intermediate [intə'mi:diət] *a.* 中间的，中等程度的，中级的
18. reduction [ri'dʌkʃən] *n.* 减少，削减
19. gear [giə] *n.* 齿轮
20. dictate [dik'teit] *v.* 命令，规定，要求，指定
21. configuration [kən,figju'reiʃən] *n.* 组态，配置
22. ring [riŋ] *n.* 轴环
23. shoulder ['ʃəuldə] *n.* 轴肩
24. restrain [ri'strein] *v.* 抑制，遏制
25. retain [ri'tein] *v.* 保留，保持
26. diagram ['daiəgræm] *n.* 图表，图解
27. bending moment *n.* 弯矩
28. distribution [distri'bju:ʃən] *n.* 分发，分配，配给物
29. carbon ['ka:bən] *n.* 碳，碳棒

30. medium [ˈmiːdiəm] *n.* ①中间
②媒介物，媒体
a. 中间的，中等的，适中的
31. elongation [iːlɔŋˈgeiʃən] *n.* 伸长，延长
32. ultimate strength *n.* 强度极限
33. yield strength *n.* 屈服极限
34. percent elongation *n.* 弯曲疲劳极限
35. appropriate [əˈprəupriət] *a.* 适当的，恰当的，相称的
v. (不适当的)挪用，盗用
36. reverse [riˈvəːs] *a.* 相反的，反向的
37. dimension [diˈmenʃən] *n.* (长、宽、厚、高等的)尺寸
38. tolerance [ˈtɔlərəns] *n.* 公差，容限
39. fillet [ˈfilit] *n.* 内圆角
40. radii [ˈreidiai] *n.* 半径
41. keyseat [ˈkiːset] *n.* 键槽
42. catalog [ˈkætəlɔːg] *n.* (图书、商品等的)目录
v. 登记，记载
43. resolve into 把…分解为

Notes

1. The specific tasks to be performed in the design and analysis of a shaft depend on the shaft's proposed design in addition to the manner of loading and support.

本句是一个复杂句，The specific tasks 为主语，to be performed in the design and analysis of a shaft 修饰主语部分，谓语为 depend on，宾语为 the shaft's proposed design in addition to the manner of loading and support。整句可以翻译为：在轴的设计和分析中所执行明确的任务不仅取决于受拉和受压的情况还有其推荐的设计过程。

2. 轴是组成机器的主要零件之一，一切作回转运动的传动零件(例如齿轮、蜗轮等)，都必须安装在轴上才能进行运动及动力的传递。因此轴的主要功用是支承回转零件及传递运动和动力。按照承受载荷的不同，轴可分为转轴、心轴和传动轴三类；按照轴线的形状，轴可分为曲轴和直轴两类；按照外形不同，轴可分为光轴和阶梯轴两类。

3. 轴的结构主要取决于以下因素：载荷的性质、大小、方向及分布情况；轴上安装的零件的类型、尺寸、数量以及和轴的连接方法；载荷的性质、大小、方向及分布情况；轴的加工工艺等。

Word - Study

Ⅰ. *Study the meaning of the following prefixes*:

re-: a) back

b) again

inter-: between

act	react	interact
A→B	A←B	A↔B
action	reaction	interaction
作用	反作用	相互作用

Ⅱ. *Rotate, Rotation, Rotational, Rotatable, Rotary*

Rotate	v. to (cause to) turn round a fixed point or AXIS
Rotation	n. the action of rotating
Rotational	a. of or pertaining to rotation
Rotatable	a. capable of being rotated
Rotary	a. (of movement) turning around a fixed point, like a wheel

Sentence Patterns

Considering

1. considering: *prep.*, *conj.* if you take into account the rather surprising fact (of)

Determine an appropriate design stress, *considering* the manner of loading (smooth, shock, repeated and reversed, or other).

2. considering+that/how

Propose the general form of the geometry for the shaft, *considering* how each element on the shaft will be held in position axially and how power transmission from each element to the shaft is to take place.

Exercises

Ⅰ. Give brief answers to the following questions.

1. How to select the material from which the shaft will be made?
2. What are the critical points of the shaft?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( ) torque	A) 轴肩
2. ( ) moment	B) 齿轮
3. ( ) hub	C) 力矩
4. ( ) gear	D) 转矩
5. ( ) ring	E) 轴环

6. (　) shoulder　　F) 键槽
7. (　) bending moment　　G) 弯矩
8. (　) keyseat　　H) 轮轴

Ⅲ. Fill in each of the blanks in the following sentences with words given below. Change the forms where necessary.

typical	restrain	transmit	diameter	gear
perform	torque	intermediate	carbon	mount

1. Gears, belt sheaves, chain sprockets, and other elements __________ carried by shafts exert forces on the shaft that cause bending moments.
2. Tapered circular pins can be used to __________ shaft-mounted members from both axial and rotary movement.
3. The most common bearing application is the support of a rotating shaft that is __________ power from one location to another.
4. Particularly in solid shafting, the shaft is stepped to allow greater in the middle portion with minimum __________ on the ends at the bearings.
5. Shafting is the machine element that supports a roller and wheel so that they can __________ their basic functions of rotation.
6. __________ are vital factors in machinery.
7. A shaft must have adequate torsional strength to transmit __________ and not be overstresses.
8. For diameters less than 3 in., the usual shaft material is cold-rolled steel containing about 0.4 percent __________ .
9. Shafts __________ between a line shaft and a driven machine are variously called countershafts, or jackshafts.
10. The most frequently encountered __________ problem is that it requires one bearing at each end of a shaft.

Ⅳ. Fill in the blanks with suitable words selected from the list and change the form if necessary.

force	fatigue	equivalent	mount	overloading
transmit	combination	deflection	torsion	bending

Shafts are ______ on bearings and ______ power through such devices as gears, pulleys, cams and clutches. These devices introduce ______ which attempt to bend the shaft; hence, the shaft must be rigid enough to prevent ______ of the supporting bearings. In general, the bending ______ of a shaft should not exceed 0.01 in. per ft of length between bearing supports. In addition, the shaft must be able to sustain a ______ of bending and torsional loads. Thus an ______ load must be considered which takes into account both ______ and ______ . Also, the allowable stress must contain a factor of safety which

includes______, since torsional and bending stress reversals occur.

Reading 15: Classification of Bearing

Single-Row, Deep-Groove Ball Bearing

The single-row, deep-groove ball bearing (Fig. 15.1) is what most people think of when the term *ball bearing* is used. The inner race is typically pressed on the shaft at the bearing seat with a slight interference fit to ensure that it rotates with the shaft. The spherical rolling elements, or balls, roll in a deep groove in both the inner and the outer races. The spacing of the balls is maintained by retainers or "cages". While designed primarily for radial load-carrying capacity, the deep groove allows a fairly sizable thrust load to be carried. The thrust load would be applied to one side of the inner race by a shoulder on the shaft. The load would pass across the side of the groove, through the ball, to the opposite side of the outer race, and then to the housing. The radius of the ball is slightly smaller than the radius of the groove to allow free rolling of the balls. The contact between a ball and the race is theoretically at a point, but it is actually a small circular area because of the deformation of the elements. Because the load is carried on a small area, very high local contact stresses occur. To increase the capacity of a single-row bearing, a bearing with a greater number of balls, or larger balls operating in larger-diameter races, should be used.

Double-Row, Deep-Groove Ball Bearing

Adding a second row of balls increases the radial load-carrying capacity of the deep-groove type of bearing compared with the single-row design because more balls share the load. Thus, a greater load can be carried in the same space, or a given load can be carried in a smaller space. The greater width of double-row bearings often adversely affects the misalignment capability.

Angular Contact Ball Bearing

One side of each race in an angular contact bearing (Fig. 15.2) is higher to allow the accommodation of greater thrust loads compared with the standard single-row, deep-groove bearing. The preferred angle of the resultant force (radial and thrust loads combined), with commercially available bearings having angles of 15°to 40°.

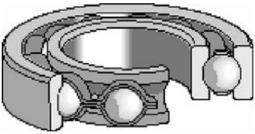


Fig. 15.1 Single-Row, Deep-Groove Ball Bearing

Fig. 15.2 Angular Contact Ball Bearing

Cylindrical Roller Bearing

Replacing the spherical balls with cylindrical rollers (Fig. 15. 3), with corresponding changes in the design of the races, gives a greater radial load capacity. The pattern of contact between a roller and its race is theoretically a line, and it becomes a rectangular shape as the members deform under load. The resulting contact stress levels are lower than for equivalent-sized ball bearings, allowing smaller bearings to carry a given load or a given size bearing to carry a higher load. Thrust load capacity is poor because any thrust load would be applied to the side of the rollers, causing rubbing, not true rolling motion. It is recommended that *no* thrust load be applied. Roller bearings are bitten fairly wide.

Needle Bearing

Needle bearings (Fig. 15. 4) are actually roller bearings, but they have much smaller-diameter rollers, as you can see by comparing Fig. 15. 3 and 15. 4. A smaller radial space is typically required for needle bearings to carry a given load than for any other type of rolling contact bearing. This makes it easier to design them into many types of equipment and components such as pumps, universal joints, precision instruments, and household appliances.

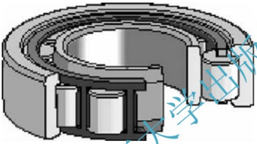


Fig. 15. 3 Cylindrical Roller

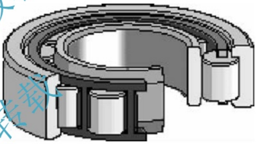


Fig. 15. 4 Needle Bearing

Spherical Roller Bearing

The spherical roller bearing (Fig. 15. 5) is one form of *self-alignment bearing*, so called because there is actual relative rotation of the outer race relative to the rollers and the inner race when angular misalignments occur. This gives the excellent rating for misalignment capability while retaining virtually the same ratings on radial load capacity.

Tapered Roller Bearing

Tapered roller bearings (Fig. 15. 6) are designed to take substantial thrust loads along with high radial loads, resulting in excellent rating on both. They are often used in wheel bearings for vehicles and mobile equipment and in heavy-duty machinery having inherently high thrust loads.

Fig. 15. 5 Spherical Roller Bearing

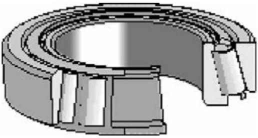


Fig. 15. 6 Tapered Roller Bearing

参考译文：

Reading 15　轴承的分类

单列深沟球轴承

单列深沟球轴承(图 15.1)，大多数人把其当成球轴承使用。内圈通常由于轻微的过盈配合被压在轴上，确保它绕轴旋转。球形的旋转体，或者叫滚动体，在内圈深沟和外圈深沟里滚动。滚动体的间隙由保持架或保护罩来维持。当主要考虑径向载荷承载能力时，深沟球轴承能够承担一个较大的轴向载荷。轴向载荷可以通过轴上的轴肩，作用于内圈的一侧。载荷可能会通过沟的侧面穿过滚动体，到达外圈的另一侧，然后到达轴承盖。滚动体的半径比深沟的半径要小，目的是滚动体能够自由滚动。在理论上，滚动体和圈的接触面是一个点，但是实际上由于滚动体的变形，其接触面是一个小的圆弧。因为载荷作用在一个小范围内，局部会产生较大的接触压力。为了增加单列深沟球轴承的载荷，可以增加滚动体的数量，或者采用较大的滚动体在大直径的滚道里滚动。

双列深沟球轴承

双列深沟球轴承与单列深沟球轴承相比，可以承担更大的径向工作载荷，因为由更多的滚动体来分担载荷。因此，在同一个尺寸上能够承担更大的载荷，或者较小的尺寸能承担已给定的载荷。双列轴承的宽度越宽，承受各个方向的载荷的能力越强。

角接触球轴承

与标准的单列或双列球轴承相比，在角接触球轴承(图 15.2)中，每个圈的一面越高，能够承担的轴向载荷就越大。合力的优先角度(径向载荷和轴向载荷的结合)工业用轴承为 15°～40°。

圆柱滚子轴承

用圆柱滚子代替球形滚动体(图 15.3)，在内圈和外圈的设计上有相应的改变，从而可以承担更大的径向载荷。滚子和轴圈的接触面理论上是一条线，和其他轴承一样在载荷的压力下变形，接触面会变成一个矩形。所形成的接触压比相同规格的球轴承小，也就是说，更小的圆柱滚子轴承可以承担已定的载荷或给定规格的圆柱滚子轴承能够承担更大的载荷。由于任何轴向载荷将被作用在滚动体的一边，将会产生摩擦，而不是真正的滚动从而降低了轴承的承载能力。它不应承担轴向载荷。滚子轴承使用范围相当广泛。

滚针轴承

滚针轴承(图 15.4)实际上也是的滚子轴承，但是它们的滚子更小，从图 15.3 和图 15.4 中，我们可以发现圆柱滚子轴承和滚针轴承的区别。当承担一定的载荷时，与其他任何类型轴承相比，滚针轴承有更小的滚动体和轴承半径。这使滚针轴承更易于应用在很多设备和机器上，如泵、万向转接头、精密仪器和家用电器。

调心滚子轴承

调心滚子轴承(图 15.5)是自位轴承的一种形式，之所以叫调心滚子轴承，是因为当内

外圈偏斜出现时，外圈与滚动体和内圈有相对旋转。当在径向载荷上保留相同的等级时，这种旋转可以获得最高等级的偏斜量。

圆锥滚子轴承

圆锥滚子轴承(图 15.6)是设计用来同时承担径向载荷和轴向载荷的，使二者获得较好的等级。它们主要用于交通工具、移动设备和使用频繁的、轴向载荷大的重型机械。

Unit 16

Text 16: Computer-Aided Design and Manufacturing Squirt Shape Enters New Phase of Development

An increasing number of prosthetists are now using computer-based techniques in the planning and fabrication of prosthetic sockets. For these clinical professional computer-aided design and computer-aided manufacture (CAD/CAM) provides an alternative to hand fabrication for the production of artificial limbs, and results in greater control and productivity in the limb fitting process.

We have developed a device for the computer-aided manufacture of sockets which we call Squirt Shape. Squirt Shape is a fully-automated system for the production system for the production of sockets using computer-based shape information.

The Squirt Shape approach eliminates the need for the physical socket model that is required when molding sockets manually or when using commercial equipment for computer manufacturing of sockets. Consequently, socket production can be achieved more accurately and at lower cost than when using the other methods.

Briefly, the Squirt Shape technique uses a motion-guided extrusion device to deposit thin layers of plastic in precisely shaped cross-sectional profiles. The result is a three-dimensional object (the socket) that is composed of hundreds of plastic layers that are stacked upon one another and thermally bonded together. The socket is produced in about one hour by an unattended machine, using less than a dollar's worth of raw material. The sockets are typically fabricated with the inclusion of a standard shape at the end which facilitates assembly with the other limb components using off-the-shelf hardware.

In a new phase of development, we are investigating alternatives to traditional methods of assembling artificial limbs. Our approach will capitalize on the features of Squirt Shape to enable us to reduce or eliminate the need for fasteners such as screws, nuts and washers. Furthermore, we anticipate a reduction in the number of components needed to produce a limb, and consequently a reduction in the weight of the limb.

Our first effort this new phase of development is the integration of the socket and pylon into a single-unit structure. Software was written to add the pylon to the socket shape data, and allows for alterations in the position and orientation of the "virtual" pylon, prior to fabricated, to enable alignment changes to be made. The resultant limb can then be fabricated in standard Squirt Shape fashion.

In this instance, the composite weight was reduced from 1.44lbs to 0.7 lbs. The strength of the integrated limb was tested in a materials test machine and had a strength of 308 ft-lbs at the ankle level. Fabrication time for the integrated limb was 1-3/4 hours which, while longer than the fabrication time for the socket alone, benefits from reduced assembly time, and reduced cost from the elimination of connector hardware.

Further goals of this project include the incorporation of the prosthetic foot, or portions of the foot, into the integrated limb, and the development of specialized attachment hardware for use with Squirt Shape. These improvements will increase the utility of CAD/CAM methods in prosthetics by further increasing productivity, accuracy, and reproducibility as compared to other production methods.

Words and Expressions

1. squirt	[skwə:t]	*n.* 注射，喷射
2. prosthetist	['prɔsθitist]	*n.* 修复学家
3. fabrication	[fæbri'keiʃən]	*n.* 制造，建造，装配，制作
4. socket	['sɔkit]	*n.* 插座，窝，穴，牙槽
		v. 给…配插座
5. clinical	['klinikəl]	*a.* 临床的
6. alternative	[ɔ:l'tə:nətiv]	*n.* 二选一，供替代的选择
		a. 供选择的，选择性的，交替的
7. artificial	[ɑ:ti'fiʃəl]	*a.* 人造的，仿造的，假装的
8. limb	[lim]	*n.* 肢，腿，臂，翼，翅膀
9. layer	['leiə]	*n.* 层，一层，阶层，层次
10. deposit	[di'pɔzit]	*v.* 存放，使沉积
		n. 存款，保证金
11. extruder	[ek'stru:də]	*n.* 挤压机，挤出机
12. stack	[stæk]	*v.* 使堆叠，把…堆积起来
		n. 堆，堆叠
13. thermally	['θə:məlli]	*ad.* 用热的方法，热地
14. profile	['prəufail]	*n.* 侧面，轮廓，外形，剖面

15. facilitate [fə'siliteit] *v.* 促进，帮助，使容易
16. inclusion [in'klu:ʒən] *n.* 包含；内含物
17. integration [inti'greiʃən] *n.* 综合，整体，一体化
18. pylon ['pailən] *n.* 桥塔，指示塔，高压线铁塔
19. orientation [ɔ:rien'teiʃən] *n.* 方向，定向，向东方
20. alignment [ə'lainmənt] *n.* 结盟，队列，成直线
21. resultant [ri'zʌltənt] *n.* 合力，结果
    a. 结果的，合成的
22. conventional [kən'venʃənəl] *a.* 常见的，惯例的，符合习俗的，传统的
23. depend upon/on 依靠，信赖
24. as a consequence 因而，结果
25. in addition to 除…之外
26. be dependent upon 依赖于
27. in that case 既然那样

Notes

1. 快速原型与制造技术(快速成形)是利用计算机辅助设计建立的数据库中信息来生成零件的分层截面轮廓数据，然后在计算机控制下，按照分层截面轮廓将材料逐层累加成形。快速原型与制造技术可以快速制取任意复杂形状的零件，而且无需刀具、夹具。

2. We have developed a device for the computer-aided manufacture of sockets which we call Squirt Shape.

此句为一宾语从句，宾语为 device，其中的 the computer-aided manufacture of sockets which we call Squirt Shape 修饰宾语 device，整句可翻译为：我们已经研制出一种利用计算机辅助生产型腔的设备，该设备我们称作喷射成形设备。

Word - Study

Ⅰ. *The prefix co-can be added to words with meaning*

1. together; with

e. g. coexist (=exist together or at the same time)

coeducation (=of boys and girls together)

2. Do something with something else

a) as an equal,

e. g. my coauthor(=someone who wrote the book with me)

b) with less responsibility; assistant

e. g. the copilot(=someone who helps the pilot)

Ⅱ. *The prefix cross-can be added to words with meaning*

1. going from one side to the other, across
2. going between the stated things and joining them

Sentence Patterns

Prior to

heat a metal <u>*prior to*</u> working it.

mixes air with gasoline vapor <u>*prior to*</u> explosion.

Sleeves can be rolled <u>*prior to*</u> the production.

The time at which the operator can change a number of monitor parameters when the monitor is started up (<u>*prior to*</u> scheduling any jobs).

To prevent damage to valve from excessive heat during soldering, remove unions and gaskets from valve body <u>*prior to*</u> soldering.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is the definition of Squirt Shape?
2. In a new phase of development, what is the approach to investigate alternatives to traditional methods of assembling artificial limbs?

Ⅱ. Choose the English explanation from Column B to match the corresponding word in Column A.

Column A	Column B
1. ( ) crossfire	A) (a drawing of) a surface made by cutting across something at aright angles to its length
2. ( ) crossroads	B) a current in the sea, a river etc moving across the general direction of the main current
3. ( ) crosssection	C) a place where two or more roads cross
4. ( ) crosscountry	D) having the knees wide apart and ankles crossed
5. ( ) crosscultural	E) one or more lines of gunfire firing across a particular point
6. ( ) crosscurrent	F) belonging to or involving different cultures or comparison between them
7. ( ) crossstitch	G) (decorative sewing which uses) a stitch like an X made by crossing one stitch over another
8. ( ) cross-legged	H) across the fields or open country

Ⅲ. Fill in each of the blanks in the following sentences with words or phrases given blew. Change the forms where necessary.

deposit	integration	resultant	conventional	in addition to	depend upon

1. What CIM does is to reinforce the __________ to create a real-time environment.
2. The __________ geometric data stored in the computer memory may be used to produce numerical control instructions for making the parts on automated machine tools.
3. CAD/CAM __________ the maturity of digital computer.
4. __________ the direct applications of the computer for process monitoring and control, computers can also be used indirectly to serve a support role in the operations of the plant.
5. Chip thickness in __________ (up) face milling varies from a minimum at the entrance and exit of the cutter tooth to a maximum along the horizontal diameter.
6. How to use authorware to __________ application program icons in System Tray.

Ⅳ. Translate the following sentences into Chinese.

1. Co-based wire is used for lifting raw materials.
2. The impact of their steel costs may far exceed the length co-ore prices.
3. It presents the methods and results of co-link analysis application by case study.
4. Co-operation allows us to learn to unite, in cooperation we can feel the most joy and happiness.

Reading 16: CAD/CAM/CAE and RP in the Metal Forming

CAD/CAM/CAE

CAD/CAM/CAE technology, including simulation, in metal forming is effectively used to design the process and die, to investigate the effects of process parameters, to acquire high quality products, and to reduce manufacturing cost utilizing a virtual model.

The design of the process and die, and effects on process parameters are examined by:

(1) checking the mechanical form, fit, interference, and assimilability,

(2) investigating strain/stress distributions, flow patterns and dimensions of final shape,

(3) investigating flow induced defects and temperature distributions in the final shape.

The improvement of product quality is examined by investigating microstructure and grains in the products. It is possible for the reduction of manufacturing cost to decrease try-outs, rejects and lead-time.

Rapid prototyping and manufacturing

RP&M technology, including RT, has advantageous characteristics that can directly fabricate a three-dimensional part from the CAD data in CAD/CAM environment, and also the technology can rapidly manufacture plastic and metal parts indirectly or directly using RT and RM.

Hence, RP&M technology in metal forming is used to rapidly examine and verify the CAD/CAM/CAE results and to prove the process concept and die design utilizing a physical model. In addition, RP&M is used to fabricate rapidly the prototype tools based on the CAD/CAM/CAE results in order to perform the functional testing successfully.

RP&M technology is influenced by the complexity of shapes due to its fabrication principle, so that lead-time and cost are drastically reduced.

Integration of CAD/CAM/CAE and RP&M

CAM/CAD/CAE and RP&M technology have highly advantageous, so the integration of two technologies can supply a good solution to reduction of time and cost in the stage of development. The integration procedure is shown in Fig. 16. 1

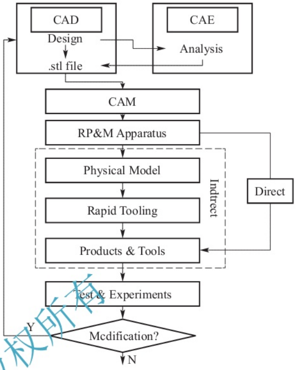


Fig. 16. 1 Integration procedure of CAD/CAM/CAE and RP&M

The key technologies are the generation of input data for a CAM system using CAD/CAE data and the fabrication of products and tools. In general, the standard input of CAM system for RP&M apparatus is . stl format with a group of triangular facets on the surface of objects. Commercial CAD software, for example, CATIA, I-DEAS, Pro-Engineer, Solidworks and so on, have their own module for data translation, so that the translation of CAD data into . stl format can be easily implemented.

The conversion of CAE results to . stl format requires special techniques. Because the intermediate shapes of a workpiece in the format of a finite element mesh data are obtained from CAE results, the conversion utilizes the mesh data in each analysis step. Firstly, the surface boundary is extracted from the solid mesh such as hexahedral or tetrahedral mesh, in order to obtain a shell mesh (Fig. 16. 2). Then, the facets of the rectangular shell mesh are divided into triangular facets are stored in . stl format.

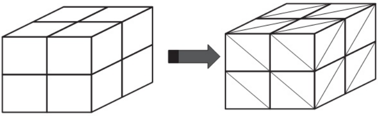


Fig. 16. 2 Schematic representation of translation of hexahedral meshes into triangular faces

The die data are generally generated from CAD data except for a special purpose such as investigation of surface defects and die deformation during forming. The workpiece data

are generated from CAE results except for the initial data.

Typically, the die and the workpiece are metallic, so that the experimental tools and initial billet should be also metallic so as to realistically undergo functional testing and experiments. The tools and products can be manufactured directly in the RP&M apparatus, for example SLS, and indirectly using RT technology such as lost wax casting, spray metal tooling, etc. The indirect tooling technology includes multiple steps of reversals to produce metallic parts.

In general, it is preferable to select the indirect RT due to dimensional accuracy, surface roughness and strength of parts comparing with the direct RT.

参考译文：

Reading 16　CAD/CAM/CAE 以及金属成形中的快速成形技术

CAD/CAM/CAE

在金属成形中，CAD/CAM/CAE，包括模拟技术都被有效地应用于设计工艺尺寸和模具以及为了获得高质量的产品和减少生产实际模型的成本上。

工艺尺寸和模具的设计以及工艺尺寸系数效用是由以下方法检验的：

（1）检查机器外形、配合、干涉和可同化性。

（2）研究应力、应变分布，流动形式和最后形状的尺寸。

（3）研究在最终成形时估算出流动导致的缺陷和温度分布。

产品质量的提高通过研究产品中的显微结构和晶粒来检验。通过减少试验，降低废品率和更换模具的时间是有可能降低生产成本的。

快速成形和加工

包括 RT 在内的 RP&M 技术的特点具有其特有的优势，在 CAD/CAM 环境下，利用计算机辅助设计数据直接制造三维工件。而且，这种技术也能使用 RT 和 RM 技术直接或间接快速地加工塑料和金属工件。

因此，在金属成形中的 RP&M 技术被应用于快速检验和验证 CAD/CAM/CAE 的结果，也被应用于利用物理模型来证明工艺尺寸和模具设计的正确性。此外，RP&M 技术也被应用在根据 CAD/CAM/CAE 的结果快速制造原型刀具上面，这样可以较好地实现功能检测。

RP&M 技术受由制造原理决定的模型形状复杂性的影响，因此加工时间和成本被大大削减。

CAD/CAM/CAE 和 RP&M 的集成

CAD/CAM/CAE 和 RP&M 技术具有非常大的优势，因此两种技术的结合在发展阶段为减少加工时间和成本提供了一个好方法。其结合过程如图 16.1 所示。

技术的关键在于 CAM 系统使用CAD/CAM 数据而生成的输入数据以及产品和刀具的制造。一般来说，为 RP&M 结构而进行的 CAM 系统的标准输入是 .stl 格式，在物体的表面有一组三角形截面。商业 CAD 软件，如 CATIA、I-DEAS、Pro-Engineer、Solid-

works 等，都有自身用于数据翻译的组件，因此把 CAD 数据翻译成 .stl 格式能够轻易实现。

CAE 结果转换成 .stl 格式需要特殊的技术。以有限元网格数据格式存在的工件的中间形状是从 CAE 结果获得的，转换在每一步分析中都用到了网格数据。首先，界面边缘从实体网格中分离出来，如六面体网格和四面体网格，以获得框架网格(图 16.2)，然后，矩形框架网格的界面被分割成三角形截面，以 .stl 形式储存。

除了研究表面缺陷和模具成形中变形等特殊目的以外，一般来说，模具数据从 CAD 数据中得到。除了原始数据，工件数据从 CAE 结果中生成。

通常模具和工件是金属制的，因此实验刀具和原材料也应该是金属的以便在实际中经得起检测和实验。RP&M 结构可以直接生产产品和刀具，如 SLS；使用 RT 技术能间接生产，如熔模铸造、喷射技术加工等。间接的加工技术包括生产技术工件的多步反向加工。

一般来说，由于尺寸精确性、表面粗糙度和工件受力的要求，和直接 RT 技术相比，间接 RT 技术更受欢迎。

Unit 17

Text 17: Open-loop Circuit and Control

An open-loop circuit or system is one in which feedback is not employed. The performance characteristics of the circuit are determined by the characteristics of the individual components used and their interaction in the circuit. Fig. 17. 1 illustrates such a circuit.

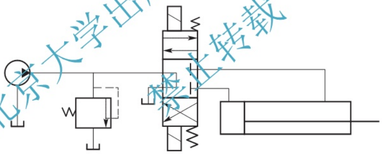


Fig. 17. 1　Open-loop Circuit

Classifications of Open-loop Circuits

There are many ways to classify open-loop circuits.

For example, they may be classified by

(1) the function they are to perform,

(2) the method by which they achieve control,

(3) system type,

(4) application area.

All of these circuit classifications are in common use today.

Functions of Open-Loop Circuits

Classifications by function of open-loop circuits are related to the basic areas of control:

(1) **Flow control.** The purpose of flow control is to regulate the energy transfer rate by regulating the flow rate in a circuit or branch of a circuit.

(2) **Pressure control.** The purpose of pressure control may be either (1) to regulate energy transfer by regulating pressure level or (2) to use a specific pressure level as a signal

to initiate a secondary action.

(3) **Direction control.** This is control of the distribution of energy in a fluid power circuit.

Method by which Open-Loop Circuits Achieve Control

Control can be achieved in a fluid power circuit by one of these three fundamental methods:

(1) Valve control. Valving is applied to give the desired mode of control.

(2) Pump control. The pump itself, almost of necessity a variable-volume pump, provides control.

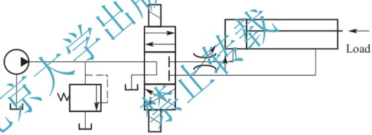
(3) Actuator control. The displacement of the actuator(most frequently a rotary motor) is varied to provide control.

These three methods apply within the functional of control as follows:

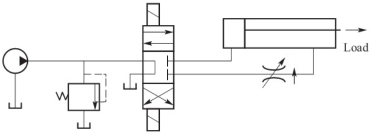
1. Flow control

(1) Valve control utilizes one of the several types of compensated or uncompensated flow control valves. The position of the flow control valve in the circuit determines the appropriate type to use:

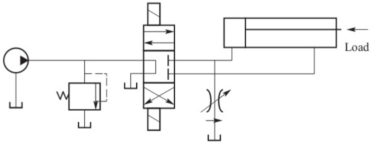
① Meter-in: The valve is placed between the source of energy and the actuator. (See Fig. 17. 2(a)).



(a) Meter-in



(b) Meter-out



(c) Bleed-off

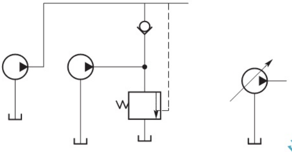
Fig. 17. 2　Valve control

② Meter-out: The valve is placed in the return line from the actuator. It controls the energy transfer by limiting the rate of flow out of the the actuator. (See Fig. 17. 2(b)).

③ Bleed-off: The valve is placed in parallel with the actuator. It limits the rate of energy transfer to the actuator by controlling the amount bypassed through the parallel circuit. (See Fig. 17. 2(c)).

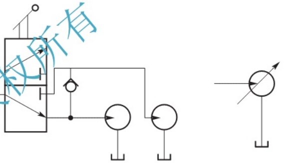
(2) Pump control implies one of two control methods, depending on which type of pump is used. Multiple pumps give a step variation in flow rate (see Fig. 17. 3(a)); variable-volume pumps give infinite variation in flow rate (see Fig. 17. 3(b)).

(3) Actuator control uses the same techniques as pump control and thus involves the use of multiple motors (see Fig. 17. 4(a)) for step variation or variable-displacement motors (see Fig. 17. 4(b)) for infinite variation in output speed.



(a) Multiple Pumps (b) Variable-Volume Pumps

Fig. 17. 3 Pump control



(a) Step Variation (b) Infinite Variation

Fig. 17. 4 Actuator control

2. Pressure Control

Valve control uses one or more of the types of pressure control valves. There are four important types.

(1) Relief valves limit the maximum energy level of the system by limiting the maximum pressure. (See Fig. 17. 5).

(2) Unloading valves regulate the pressure level by providing a bypass for the circuit flow, so that it is carried back to the tank at a low energy level. Unloading valves are activated when the pressure reaches a certain "set" level(See Fig. 17. 6).

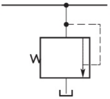


Fig. 17. 5 Relief Valves

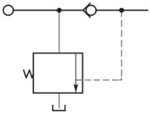


Fig. 17. 6 Unloading Valves

(3) Sequence valves react to a pressure signal to switch flow to a secondary circuit. Thus they divert energy from the primary circuit to the secondary(See Fig. 17. 7).

(4) Reducing valves react to a pressure signal to throttle flow to a secondary circuit, thereby delivering energy at a lower level than that in the primary circuit(See Fig. 17. 8).

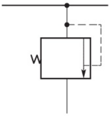


Fig. 17. 7　Sequence Valves

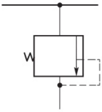


Fig. 17. 8　Reducing Valves

3. Direction control

(1) Valve control uses one of the many types of direction control valves to regulate the distribution of energy throughout the circuit. These valves switch the flow streams entering and leaving the valve.

(2) Pump control is limited to reveral of direction of flow from a variable-volume reversible pump.

(3) Actuator control is similar to pump control; it uses reversible, variable-volume motors.

Words and Expressions

1. circuit　['sə:kit]　*n.* 回路，电路
2. fluid　['flu:id]　*a.* ①流体的②液压的
　n. 流体
3. employ　[im'plɔi]　*v.* 用，使用，采用
4. performance　[pə'fɔ:məns]　*n.* ①性能②表现
5. interaction　[intə'rækʃən]　*n.* 相互作用
6. achieve　[ə'tʃi:v]　*v.* ①获得②完成
7. flow　[fləu]　*n.* ①流量②留，流出
　v. ①流动②(血液)循环，流通
8. regulate　['regjuˌleit]　*v.* ①控制②调节③校准
9. transfer　[træns'fə:]　*n.* 移动，转移
　v. ①转移，移动②传递
10. initiate　[i'niʃieit]　*v.* 开始，发动
11. valve　[vælv]　*n.* 阀
　v. 用阀调节
12. pump　[pʌmp]　*n.* 泵
13. actuator　['æktʃueitə]　*n.* 执行器，传动装置

14. utilize	['juːtilaiz]	*v.* 利用
15. source	[sɔːs]	*n.* ①电源②源，源泉
16. bypass	['bai,pɑːs]	*v.* 设旁路，迂回
		n. 旁路，支路
17. parallel	['pærəlel]	*a.* ①平行的②同样的，对应的
18. multiple	['mʌltipl]	*a.* 复合的
19. sequence	['siːkwəns]	*n.* 顺序，序列
20. throttle	['θrɔtl]	*v.* 节流
		n. 节流阀
21. potential	[pə'tenʃəl]	*n.* ①位势，电压②潜能
		a. ①位的②潜在的
22. reversible	[ri'vəːsəbl]	*a.* 可转换的，可逆的
23. open-loop circuit		开环回路
24. compensated flow control valve		带压力补偿的流量控制阀
25. uncompensated flow control valve		无压力补偿的流量控制阀
26. return line		回流管，回路
27. relief valve		安全阀
28. unloading valve		卸压阀
29. sequence valve		序列/顺序阀
30. reducing valve		减压阀

Notes

1. The performance characteristics of the circuit are determined by the characteristics of the individual components used and their interaction in the circuit.

本句的主要结构是 The performance characteristics used are determined by the characteristics，其中 used 做后置定语修饰 components。全句译为：回路的性能特点由所组成的单个元件的特点和它们在回路中的相互作用决定。

2. Unloading valves regulate the pressure level by providing a bypass for the circuit flow，so that it is carried back to the tank at a low energy level.

本句中 unload 的现在分词做形容词修饰 valves，so that 引导结果状语从句，at … level 意为“以某种水平”，全句译为：通过对回路流量进行分流来调节压力，因此油液返回油箱时的压力较低。

Word - Study

Ⅰ. *Perform, Performance*

1. Work is performed by the steam during expansion.
2. Compression can be performed in two or more stages.
3. The performance of the aircraft is very satisfactory.
4. Modifications to the engine improved its performance considerably.

Ⅱ. *Involve, Entail*

1.	The fitting of a super heater	involves entails	a considerable extra cost.
2.	Rapid compression of a gas		a rise in temperature.
3.	The planning of road gradients		moving large quantities of earth.
4.	Less manual labor is involved in the handling of oil than coal.		
5.	All the engineers are involved in the dispute over wages.		

Sentence Patterns

Ⅰ. Dependence

a)	dependable=reliable
b)	dependent on =rely on =count on
c)	be dependent on

1. The aircraft is dependable (reliable). You can depend on (rely on) it. It will not break down.
2. The aircraft depends on its wings and engines to provide lift.
3. Sweden is dependent on her hydro-electric resources for power.
4. The hardness of the steel relies on (depends on/is dependent on) the proportion of carbon it contains.

Ⅱ. Function

1.	The function of	the super heater	is to	raise the temperature of the steam.
2.		the governor		control the speed of the engine.
3.		the spring		keep the weights depressed.

4.	The super heater	has	the function of	raising the temperature of the steam.
5.	The governor			controlling the speed of the engine.
6.	The spring	performs		keeping the weights depressed.

7. The super heater serves to raise the temperature of the steam.

=The super heater serves as the means of raising the temperature of the steam.

8. The governor acts as a method of controlling the speed of the engine.

9. The spring is used as a way of keeping the weights depressed.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What determines the performance characteristics of the circuit?
2. How many ways are there to classify open-loop circuits?
3. What are the basic areas of control?

Ⅱ. Match the items listed in the following two columns.

Column A	**Column B**
1. ( ) performance	A) 开环回路
2. ( ) valve	B) 顺序，序列
3. ( ) potential	C) 双向的
4. ( ) open-loop circuit	D) 性能
5. ( ) sequence	E) 相互作用
6. ( ) reversible	F) 位势，液压
7. ( ) interaction	G) 阀

Ⅲ. Finish the following sentences by using *dependable*, *reliable*, *depend on*, *rely on*, or *be dependent on*, and change the forms where necessary.

1. The amount of expansion which takes place __________ the coefficient of expansion of the metal.
2. The saturation pressure of a vapor __________ its temperature.
3. The building work will start this month or next __________ how soon enough labor is available.
4. The depth of the road surface will __________ the volume of traffic it carries.
5. This country __________ imports from abroad for more than half its food.
6. The motor may be large or small __________ the power it has to give.
7. Whether the research program will continue or not __________ the cost.
8. The value of metal __________ whether it is rare or abundant.
9. The passengers __________ the pilot and navigator for their safety.
10. A number of different tools are available __________ the amount of money you can

spend on them.

Ⅳ. Fill in each of the blanks in the following sentences with words given blew. Change the forms where necessary.

perform	involve	performance	source	potential

1. Tests must be __________ on the material to establish that it can be safely used.
2. This faulty connection is the __________ of the engine trouble.
3. This new invention has an enormous sales __________ .
4. Modifications to the lathe improved its __________ greatly.
5. A number of factors are __________ in measurement of radiation dose.

Reading 17: Types and applications of Open-Loop Circuits

There are two basic types of open-loop circuits is open-center and closed-center. Fig. 17. 9 shows a typical open-center circuit. These circuits have the following characteristics:

(1) A direction control valve unloads the pump, bypassing fluid to the tank when the valve is in the centered or neutral position.

(2) A fixed-displacement pump is most commonly used.

(3) Energy transfer starts from a low level (essentially zero) when the valve is in neutral, and builds up as the valve is shifted. This shifting of the valve causes the fluid stream to move into the actuator and therefore to exert itself against the load resistance.

(4) Internal leakage is minimal when the valve is in centered position, unless the actuator is supporting a load in an elevated position.

(5) In general, open-center circuits are the least expensive, provided they meet performance requirements.

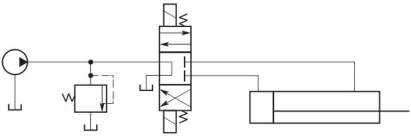


Fig. 17. 9 Open-center Circuit

Fig. 17. 10 shows a typical closed-center circuit. Note that such a circuit uses a fix-displacement pump, an unloading valve, and an accumulator. Closed-center circuits have the following characteristics:

(1) All ports are blocked when the direction control valve is in its centered or neutral position.

(2) If a fixed-displacement pump is used, ordinarily an accumulator is also used and an unloading valve is required.

(3) Energy transfer starts from a high level, from the maximum pressure setting of the system. The energy is available to the actuator as soon as the valve is shifted.

(4) Internal leakage is of more concern here than in open-center circuits, since the valve is holding against full system pressure at all times.

Fig. 17. 11 shows a second version of the closed-center circuit. This circuit uses a pressure-compensated variable-volume pump instead of the fixed-displacement pump, accumulator and unloading valve used in the circuit of Fig. 17. 10. The characteristics of this circuit are the same as the ones noted for the first version of the closed-center circuit.

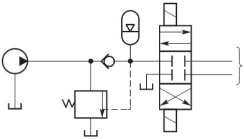


Fig. 17. 10 Closed-center Circuit Ⅰ

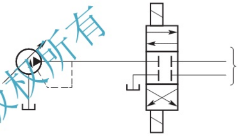


Fig. 17. 11 Closed-center Circuit. Ⅱ

The method of classifying circuits is by their applications. This is a very broad and very flexible type of classification. The following outline illustrates the method and suggests the range of current industrial applications.

1. Machine-tool applications

(1) Feed circuits. These provide flow control by regulating the speed of the actuator.

(2) Transfer circuits. These provide direction control primarily. They are used where it is desirable to regulate acceleration, velocity, or deceleration.

(3) Clamping circuits. These provide direction control, and possibly pressure control as a secondary function.

(4) Spindle-drive circuits. These provide flow control primarily, but they may be used for secondary pressure control.

2. Press applications

(1) Heavy stamping presses.

(2) Die-casting and plastic-molding presses. The type of circuit used in these presses depends on the size of machine.

3. Materials handing

Positioning circuits, which operate as mechanisms of two kinds:

(1) Transfer mechanisms. These provide direction control, and are equipped with a mechanical stop or limit switch.

(2) Indexing mechanisms. These provide direction control.

4. Mobile equipment, aircraft, aerospace, marine, and other applications

参考译文:

Reading 17　开环回路的种类和应用

开环回路有两种基本类型，中位开式与中位闭式。图 17.9 是一个典型的中位开式回路，这种回路具有如下特点：

(1) 当阀门处在中间位置时，通过让油液流向油箱，方向控制阀对液压泵进行卸压。

(2) 多数情况下使用定排量泵。

(3) 当阀门在中间位置时，最初传递的液压能很低(实际上为零)，当阀门移动时，液压能逐渐增加。这种阀门的移动会使油液流动至执行装置，从而使其承受负载阻力。

(4) 当阀门在中心位置时，只要执行装置不承受高位负载，内部泄漏为最低。

(5) 一般而言，只要能够满足性能要求，中位开式回路成本最低。

图 17.10 所示的是一个典型的中位闭式开环回路。该回路使用定排量泵、卸压阀和执行装置。中位闭式开环回路具有以下特点：

(1) 当方向控制阀在中心位置时，所有油路都会断开。

(2) 如果应用定排量泵，一般还要使用蓄电池与卸压阀。

(3) 液压能最初较高，并从系统设定的最大压力开始传递。阀门变换时，执行装置将获得液压能。

(4) 与中位开式回路相比，在中位闭式回路中，应多考虑内部泄漏的问题，因为阀体始终都在承受整个液压系统的压力。

图 17.11 上所示为中位闭式开环回路的另一种类型。该回路使用如图 17.10 所示的压力补偿变量泵代替定排量泵，同时应用蓄电器和卸压阀。该回路的特点与中位闭式开环回路的第一个类型相同。

回路可根据它们的应用范围进行分类，分类方法广泛而灵活。其分类方法以及当前在工业中的应用范围介绍如下。

1. 机床应用

(1) 补给回路。通过调节执行件的运动速度来实现流量控制。

(2) 传动回路。主要进行方向控制。在需要调节加速、速度或减速的位置，使用传动回路。

(3) 锁紧回路。可以进行方向控制，也可进行压力控制。

(4) 驱动轴回路。主要进行流量控制，也可用于次级压力控制。

2. 压力机的应用

(1) 重型冲压机

(2) 压铸和塑料成型压力机。所采用的回路类型取决于机器的尺寸。

3. 材料处理

定位回路，可操作以下两种机械装置。

(1) 传动装置。进行方向控制，装备有机械挡块或限位开关。

(2) 分度装置。进行方向控制。

4. 移动装置、飞机、航天器、船舶及其他应用

Unit 18

Text 18: Basic of Industrial Robots

As can be seen from the title of this chapter, we will limit our discussion to industrial robots. Also, the chapter is aimed mainly at providing the manufacturing engineer with an introductory, yet complete, picture about this emerging kind of automation. Accordingly, further details are considered to be beyond the scope of the present text, and interested readers can find such details in any of the specialized books given in the first of references.

Let us start our discussion by trying to find an appropriate definition for the word *robot*. In fact, there are many definitions; some are general, whereas others include a variety of devices, some of which can hardly be called robots[1]. In the early days of robots, the Japanese defined an industrial robot as an all purpose machine, equipped with a memory and an appropriate mechanism to perform motions automatically, thus replacing human labor[2]. Later, JIRA (Japanese Industrial Robots Association, Tokyo) gave a definition of industrial robots that includes the following six categories:

1. *Manual manipulator*. A manipulator that is worked by an operator.

2. *Fixed-sequence robot*. A manipulator that repetitively performs successive steps of a given operation according to a predetermined sequence, condition, and position, and whose set information cannot easily be changed.

3. *Variable-sequence robot*. A manipulator that performs successive steps of a given operation according to a predetermined sequence, condition, and position, and whose set information can easily be changed.

4. *Playback robot*. A manipulator that can produce, from memory, operations originally executed under human control. A human operator initially operates the robot in order to input instructions. All the information relevant to the operations (sequence, conditions, and positions) is put in memory. When needed, this information is recalled (or played back) and the operations are repetitively executed automatically from memory.

5. *NC robot*. A manipulator that can perform a given task according to the sequence,

conditions, and positions commanded via numerical data. The software used for these robots includes punched tapes, cards, and digital switches. This robot has the same control mode as an NC machine.

6. *Intelligent robot*. This robot has sensory perception (visual and/or tactile) and can detect changes by itself in the work environment or work condition and use its own decision-making facility to proceed with its operation accordingly.

Another narrower definition is given by RI (Robot Institute of America, Dearborn, Michigan), which defines a robot as "A reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks." The RI definition of robots excludes the first and the second categories of the Japanese definition. This is, in fact, in agreement with the recent trends, which require that robots be easily programmed[3]. Excluding manual manipulators and fixed-sequence robots, we can easily realize that robots are actually a kind of NC machine. In fact, the control units of NC machine tools and robots are virtually alike, and the servo drive motor and drive circuitry in each are exactly the same. We therefore always refer to what we know about NC machines when discussing robots.

Words and Expressions

1. industrial robots　　工业机器人
2. automation　[ɔːtə'meiʃən]　*n.* 自动化(技术)，自动操作
3. device　[di'vais]　*n.* ①装置，设备，器具②手段，策略
4. sequence　['siːkwəns]　*n.* ①有关联的一组事物，一连串 ②先后次序，顺序，连续
　v. 按顺序排列
　v. 使按顺序排列
5. manipulator　[mə'nipjuleitə]　*n.* 操作者，操纵者，操纵器
6. execute　['eksikjuːt]　*vt.* ①将…处死，处决，处以极刑 ②履行，执行，贯彻，实行，
　vi. 执行，履行；实行，实施；完成
7. punch　[pʌntʃ]　*vt.* ①用拳猛击②打孔
　n. ①猛击，拳打②冲床，穿孔机
　vi. ①冲压②用拳猛击，攻击
8. exclude　[ik'sklud]　*v.* ①排除，不包括在内 ②防止…进入；阻止…参加
9. servo　['səːvəu]　*n.* 伺服，伺服系统

10. circuitry	['səːkitri]	*n.*	电路，线路
11. motor	['məutə, 'məutə(r)]	*v.*	①驾驶［乘］汽车②乘车旅行；驾车旅行
		a.	有引擎的，由发动机推动的
		n.	马达，发动机②汽车
12. tactile	['tæktəl, -, tail]	*a.*	①触觉的；触觉感知的
			②能触知的；有形的
			③(绘画)具有浑厚坚实质感的

Notes

1. In fact, there are many definitions; some are general, whereas others include a variety of devices, some of which can hardly be called robots.

本句的主句是 there be 句型，连词 whereas 连接两个并列句，此并列句中又有 which 引出的非限定性定语从句，其先行词为 device。

译文：事实上，关于机器人的定义有很多，有的是概括性的，有的则包含各种各样的装置，其中一些已很难被称作机器人。

2. In the early days of robots, the Japanese defined an industrial robot as an all purpose machine, equipped with a memory and an appropriate mechanism to perform motions automatically, thus replacing human labor.

本句 equipped with 引导的部分做后置定语，修饰 machine；其中 and 连接的并列成分为 a memory 与 an appropriate mechanism；thus 表结果。

译文：机器人出现的早期，日本人将工业机器人定义为一种万能机器，配有存储器和恰当的机构，可以自动完成动作，以代替人力劳动。

3. This is, in fact, in agreement with the recent trends, which require that robots be easily programmed.

本句有几个重要的语言点：①in fact 为插入语，位置相对灵活，句首、句中、句尾均可；②介词短语 in agreement with 意为“与…一致”；③which 引导非限定性定语从句修饰 the recent trends；④require 后接 that 引导的定语从句，从句中用 should＋$V_{原}$ 表示虚拟，should 可以省略。本句可译为：实际上，这与最近要求机器人便于程式化的发展趋势相吻合。

Word - Study

Base, Basis, Basic, Foundation, Ground

These nouns all pertain to what underlies and supports.

Base   is applied chiefly to material objects.

Basis	is used in a nonphysical sense or a figurative situation.
Basic	can be used as a noun, it refers to an essential, fundamental element or entity. actually it is often used as an adjective which means essential, the most important.
Foundation	applies physically (the foundation of a house) and figuratively (a statement without foundation in fact). It often stresses firmness of support for something of relative magnitude;
Ground	may denote an actual working surface, as in art (a white design on a blue ground), more often it is used figuratively in the sense of a justifiable reason.

Sentence Patterns

the more ……the more

"The+形容词/副词的比较级……，the+形容词/副词的比较级……。"句型表示前者和后者在程度上同样增加或减少。译为：越……就越……，前面的句子用一般现在时，后面的句子使用一般将来时或一般现在时；或者前后的句子都用一般过去时。

The more	a person reads,	the wiser	he will become.
	I thought of it,	the more frightened	I felt.
	careful you are,	the fewer mistakes	you will make.

Exercises

Ⅰ. Give brief answers to the following questions.

1. How did the Japanese defined an industrial robot in the early days of robot?
2. How many categories in the definition given by JIRA? What are they?
3. What's the definition of a robot given by RI?

Ⅱ. Choose the best answers.

1. It's believed that ______ you work, ______ result you will get
   A. the harder; the better　　B. the more hard; the more better
   C. the harder; a better　　D. more hard; more better
2. The more you eat, ______ you will become.
   A. the fat　　B. fatter　　C. the fatter　　D. fat
3. The more they tried to help him, ______ he seemed to appreciate it.
   A. less　　B. lesser　　C. the less　　D. the little
4. (改错)The more he thought of that, the more worriedly he felt about his mother. ______.
5. (改错)The more careful you are, fewer mistakes you will make. ______.

Ⅲ. Fill in the following blanks with words mentioned in Word Study part.

1. What a freshman must learn about for the first semester is the ________ of math.
2. He has good ____________ for what he thinks.
3. Visitors from home and abroad are all amazed by the size of the monument's ________.
4. "Our flagrant disregard for the law attacks the ______________ of this society" (Peter D. Relic).
5. Their friendship is on shaky ____________.
6. "The ____________ of a democratic state is liberty" (Aristotle).

Reading 18: Non-servo-controlled Robots

Non-servo-controlled robots are the simplest type of robots, and the members of this group fall under the first and second categories of the JIRA definition of robots. These robots are inexpensive, are simple to set up and program, have reasonable precision, and provide a "start-simple" approach to robotics.

Like the other type of robots, a non-servo-controlled robot is composed of a mechanical unit (manipulator) and a control unit (controller). The mechanical unit has moving parts that perform the work, and the controller directs the mechanical unit in carrying out its task. Non-servo-controlled robots are air-powered and operate by employing transporters along a Cartesian coordinate system on a point-to-point basis. The different points throughout a cycle are fixed through the use of mechanical or electromechanical stops, but the actual path between those points cannot be defined or controlled. Angular motion around one or more of the coordinate axes is provided by rotators, in order to resemble wrist motion, i. e., roll, pitch, and yaw. It is not difficult to see that the control of motion along a single axis is based on only one command, which is either on or off, since the stops will determine the starting and the ending points of the stroke. The command (on or off) is executed through the use of a four-way solenoid-actuated valve, which controls the flow of pressurized air through the two inlets of the double-acting air cylinder of the transporter.

Obviously, the control of multimotion robot is not as easy as the preceding case, since several on-off commands must be given in a certain order to perform a required task. Accordingly, programming of non-servo-controlled, multimotion robots involves preparing a table that includes the sequence as well as the duration of the duration time of on—off commands. The program plan is then fed into the control unit, which usually involves a solid-state programmable controller for non-servo-controlled robots. When the robot is operated, on-off commands are conveyed to the different solenoid-actuated valves according to the program plan. Simple cycles, like pick-place or pick-dip-place, can be easily programmed. In addition, more complex motion patterns can also be programmed, provided that the controller used has an appropriate programming capability.

参考译文：

Reading 18　非伺服控制机器人

非伺服控制机器人是最简单的机器人类型，根据日本机器人协会对机器人的描述，这一群体成员属于其中的第一和第二类。这些机器人价格便宜，易于组装和编程，精密度也很好，并且在机器人技术方面使用了简单的开启方式。

像其他类型的机器人一样，非伺服控制机器人是由一个机械单元(操纵器)和一个控制单元(控制器)组成的。机械单元有执行工作的活动件，控制器指挥其执行任务。非伺服控制机器人是气动，并沿着直角坐标系统，通过输送装置在点与点之间运行。整个运动循环的不同之处在于：使用机械还是机电停止运转，但其实际路径仍不能定义或控制。转动轴使其围绕一个或更多坐标轴转动，与腕关节运动相似，即转动、俯仰、偏置。这就不难看出，单轴运动控制只有一个命令，即：开启或关闭，并由此确定运动的起点和终点。开或关命令由四通电磁驱动阀执行，并通过控制输送器气缸两个入口的气压来完成。

显然，为了执行必要任务，必须以一个特定的顺序给出多个开关命令，所以，多运动控制机器人并不像之前说的那样简单。因此，非伺服控制及多运动机器人的编程需要准备一个列表，其中包括执行预期事件的顺序以及不同运动轴开关命令的持续时间。然后，该程序被输入控制单元，通常包括非伺服控制机器人的固态可编程控制器。根据编程，开—关命令被传送到不同的电磁阀，并以此操作机器人。简单的循环，如拾起—放置或拾起—下降—放置，编程容易。此外，只要该控制器具有相应的可编程能力，较复杂的运动模式也可以编程。

Unit 19

Text 19: Moulds for Processing Plastic Materials ——Classification of Moulds

The moulds for making products from plastics come in various designs to suit the manufacture of different articles, the materials they are made from, the production features, etc.

The moulds are classified into compression and transfer ones.

In the compression mould (Fig. 19.1(a)), the loading chamber is a continuation of the cavity shaping the bottom of the article. The part of the mould which accommodates the loading chamber and the bottom shaping cavity is called a die. The moulding material is charged into the die where it is heated to become plastic, and rammed by the *punch*. The latter is a part of the mould transmitting the pressure upon the material and shaping the top and internal surfaces of the article[1]. The pressure exerted by the punch upon the material moulds it in the volume of the shaping cavity and imparts it the required shape. The compression mould closes completely when the article is finally shaped.

In the transfer mould, the shaping cavity is made separately from the loading chamber and is completely clamped prior to filling it with material. The material comes from the loading chamber into the moulding cavity through the sprue channels.

There are two basic types of transfer moulds:

(1) with a loading chamber (for use in presses);

(2) without a loading chamber (for use on injection machines).

Fig. 19.1(b) shows a diagram of a transfer mould for use in presses.

The transfer moulds are less efficient than the compression moulds, but they allow more accurate products of intricate shape to be obtained which require no trimming of flash[2].

The transfer moulds without a loading chamber are used only in the processing of thermoplastic compounds. Such moulds are mounted on injection machines. The material comes into the moulding cavity over the sprue channels from the heating cylinder of the injection machine.

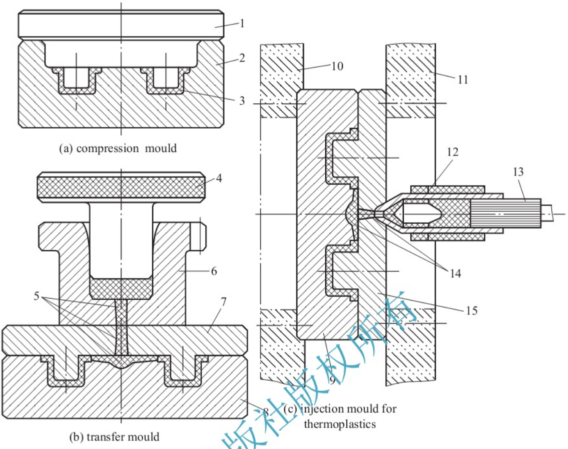


Fig. 19. 1 Diagrams of moulds

1, 4—punches; 2, 8, 9—dies; 3—article; 5, 14—sprue channels; 6—loading chamber; 7—upper platen; 10—rear(movable) platen of injection machine; 11—front(stationary) platen of injection machine; 12—heating cylinder of injection machine; 13—piston of injection machine; 15—front platen of mould

Fig. 19. 1(c) shows a diagram of the mould for injection moulding of thermoplastic materials.

As to their maintenance the moulds can be either loose or fixed. The *loose moulds* are to be removed from the press to withdraw the moulded article after each moulding operation. To heat the loose moulds, the presses are equipped with heating platens between which the mould is mounted. The loose moulds are of low efficiency, they are applicable when making small lots of products. The *fixed moulds* are rigidly joined to the platens of the press or injection machine. The ready product is removed from such moulds without removing the mould from the press[3]. The fixed moulds are provided with either a heating or cooling device depending on the type of material to be processed. Besides loose and fixed moulds there are *semi-fixed moulds* wherein only that part which moulds the product is made loose.

From the standpoint of the quantity of products which can be made at a time, or the quantity of moulding cavities, the moulds are classified into single- and multiple-cavity moulds. Another distinction between the moulds consists in the number and direction of their parting planes. A parting plane of the mould is a term applied to the surface over which the moulding parts open. The opening of the mould is necessary for loading the next portion (weight batch) of the material to be moulded and for removing the moulded article. The parting (opening) plane can be either vertical or horizontal. To remove the article vertically, the opening is to be made

over the horizontal plane. If the removal of the article calls for moving the moulding members apart horizontally, the opening plane is to be vertical[4]. The number of parting planes can be one, two, or three, depending on the shape of the article.

Words and Expressions

1. article ['ɑːtikəl] *n.* 制件，产品
2. compression [kəm'preʃən] *n.* 压缩
3. transfer [træns'fəː] *n.* 传递
4. loading chamber 加料腔，加料室
5. cavity ['kæviti] *n.* 型腔，模腔
6. accommodate [ə'kɔmədeit] *v.* ①容纳，调节②使适应
7. ram [ræm] *v.* 填满，填入
8. exert [ig'zəːt] *v.* 施加(压力，影响等)
9. clamp [klæmp] *v.* ①锁紧②夹住
10. sprue channel 主浇道
11. intricate ['intrikit] *a.* 复杂的
12. trimming ['trimiŋ] *n.* 修边，去毛边
13. Injection moulding 注射成型，注塑成型
14. thermoplastic compound 热塑性复合材料
15. heating cylinder 加热缸
16. maintenance ['meintənəns] *n.* ①维护，维修②保持
17. consist in 在于，存在于
18. parting plane 分型面，分割面
19. mounted article 成型的制件
20. vertical ['vəːtikəl] *a.* 垂直的，纵向的
21. horizontal [ˌhɔri'zɔntl] *a.* 水平的，横的

Notes

1. The latter is a part of the mould transmitting the pressure upon the material and shaping the top and internal surfaces of the article.

本句中，transmitting 和 shaping 构成的两个现在分词短语作 a part of the mould 的后置定语，起到修饰限制的作用。本句可译为：冲头是将压力施加到材料上，对制件的顶部和内表面塑形的一种模具部件。

2. The transfer moulds are less efficient than the compression moulds, but they allow more accurate products of intricate shape to be obtained which require no trimming of flash.

这是一个由转折连词 but 引导的并列句。前半句是一个比较状语从句；后半句中，to be obtained 作宾语补足语，which 引导的定语从句修饰 products。本句可译为：传递模没有压缩模效率高，但它们可以准确制作出复杂形状的产品，而无需进行去毛刺。

3. The ready product is removed from such moulds without removing the mould from the press.

本句中，without…press 作伴随状语，可译为：加工好的产品从此类模具中脱出，而无需将定模从冲压机脱出。

4. If the removal of the article calls for moving the moulding members apart horizontally, the opening plane is to be vertical.

本句是一个由 if 引导的条件状语从句。可译为：如果成形件的移除要求在水平方向上分开，则分型面应该是垂直的。

Word - Study

Ⅰ. *convert*; *transfer*; *transform*; *transmit*

应该说这四个词的区别还是比较明显的。

convert 是强调改变(某事物)的形式和用途。

比如：The sofa is *converted* into a bed.

The room was *converted* from a kitchen to a lavatory. 这件房子原来是厨房现在改为厕所了。

transfer 是指把某人某事物从一个地方转移到另一个地方，比如“迁移”，引申出来的意思；调任、换乘、转让财产等。

例如：The head office was *transferred* from London to New York. 总部已由伦敦迁往纽约。

transform 是指完全改变某人某物的外观或特性，这个词应该和 convert 着重区别。

例如：She used to be shy, but a year abroad has completely *transformed* her. 她过去很腼腆，但是在国外待了一年完全变了。

应该说 transform 和 convert 的区别还是很明显的。

transmit 是指传播信号、节目、无线电波传输等。引申出来有：把信号、知识、传染病等无形的东西传递、传染给别人、别的事物等。

例如：The world cup final is being *transmitted* live to over fifty countries. 世界杯决赛现在正在向 50 多个国家实况转播。此处 live 是现场(转播)，实况(转播)的意思。

Ⅱ. *consist in*; *consist of*

在英语里，我们常会碰到这种现象，由于所用的介词不同，其语意也就变得大不相同. 例如，consist in 表示“在于…”之意；consist of 则表示“包含”，“由…组成”之意。前者说明一样事物的性质，这种性质大都是抽象的、非物质的；后者则说明组成某一事物的部分，这些部分大都是具体的、物质的。例如：

Happiness *consists in* trying to do one's duty, not in amassing wealth.

快乐的源泉在于尽义务，而不在于积聚财富。

The best remedy for tuberculosis *consists in* rest.

肺结核病的最好良药就是休息。

The value of this teaching method *consists in* the interest it stimulates in the students.

这种教学法的优点是在于能引起学生的兴趣。

Water *consists of* oxygen and hydrogen.

水由氧和氢组成。

This delegation *consists of* ten famous actors.

这个代表团由十名著名影星组成。

Our golf club *consists of* 150 members.

我们的高尔夫俱乐部有一百五十名会员。

Sentence Patterns

Ⅰ. be of +n. /nominal phrase

Note: be of +n. /nominal phrase = be + adj.

1. The loose moulds	are of	low efficiency.	=are not efficient
2. The question	is of	great importance.	=is important
3. The drug	was of	no effect.	=was not effective
4. Even the odds and ends	may be of	use to him.	=be useful to
5. It	would be of	great value in irregular-type warfare.	=be valuable

Ⅱ. from the standpoint of …

1. *From the standpoint of* technology, is it possible to clone humans.

2. *From the standpoint of* overall resource use, the new techniques may be superior to the old, even in the poor country.

3. Symmetry is a useful tool in organizing interfaces *from the standpoint of* providing visual balance.

4. It is wrong to appraise our work either *from the standpoint of* affirming everything or *from the standpoint of* negating everything.

5. *From the standpoint of* success, a good work ethic is no less important than an education.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is the classification of the moulds?
2. What is a die?

3. How many basic types are there in transfer moulds?
4. What is the feature of loose moulds?
5. What is a parting plane of the mould?

Ⅱ. Match the items listed in the following two columns.

Column A	Column B
1. ( )sprue channel	A) 加料腔，加料室
2. ( )heating platen	B) 加热缸
3. ( )loading chamber	C) 热塑性复合材料
4. ( )injection moulding	D) 主浇道
5. ( )heating cylinder	E) 加热板
6. ( )thermoplastic compound	F) 注射成型

Ⅲ. Fill in the blanks with the words given below, Change the form where necessary.

transfer	clamp	exert	be classified into	intricate	consist in

1. ________ these two pieces of wood together.
2. Large bodies ________ a greater pull on any body than smaller ones which contain less material.
3. Plastic may be cast into varied and ________ shapes.
4. Adjustable working table stroke leads to convenient ________ of workpiece in various lengths.
5. The best remedy for tuberculosis ________ rest.
6. Properties ________ two main groups, physical and chemical properties.

Ⅳ. Fill in the blanks according to the text.

cavity	sprue channels	transfer	injection
heating	cylinder	thermoplastic	compounds

The ______ moulds without a loading chamber are used only in the processing of ______ . Such moulds are mounted on _______ machines. The material comes into the moulding ________ over the ________ from the ________ of the injection machine.

Reading 19: Moulds for Press Moulding

Let us consider several typical designs of moulds for processing thermosetting materials.

The manufacturers who specialize themselves in making products from the thermosetting materials widely apply compression moulds since they are most efficient. The compression moulding can be used for making articles of different size and shape. However they are not suitable for production of articles with thin metal reinforcements, deep holes of small diameters, or holes perpendicular to the direction of moulding.

Fig. 19. 2 shows a *loose one-impression mould with the horizontal parting plane BB for compression moulding* of the transformer housing side. The top mould with punch 5 is closed and locked by guide posts 9 with respect to the bottom. Die 4, whose top acts as a loading chamber, is of a split design to simplify the manufacturing process. The bottom of the article is moulded by part 3 known as *insert*. Insert 3 is mounted tight in the opening of die 4 and closed by backing plate 1. In the same way punch 5 is secured in plate 6 (punch holder). Parts 2 and 8 of the mould which shape the holes are called *cores*.

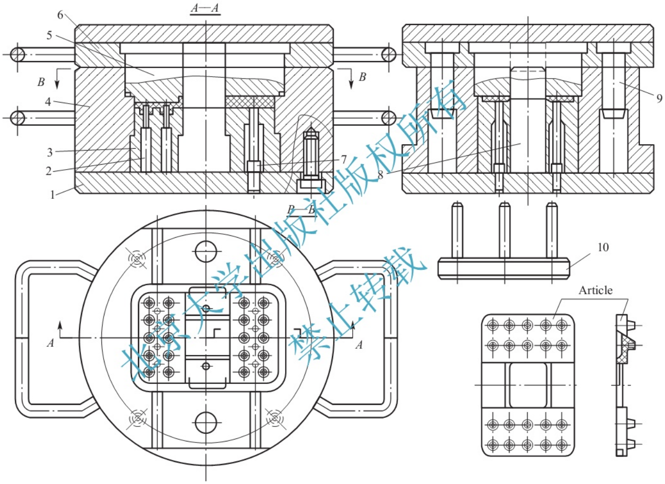


Fig. 19. 2 Loose Compression Mould

1—backing plate; 2, 8—cores; 3—insert; 4—die; 5—punch; 6—punch holder; 7—ejector; 9—guide post; 10—stripper

After the moulding operation is over, the mould is removed from the press and placed on a special device to withdraw the moulded article therefrom. The article is removed by stripper 10 whose stems move ejectors 7 through the holes in plate 1.

Fig. 19. 3 shows a *loose one-impression transfer mould with two parting planes AA and BB*. The loading chamber is mounted on top plate 1. The moulding material fills in the cavity through adapter (sprue bush)2. The external outline of the article is shaped in plates 3 and 4 while the holes are made with the aid of cores 5 and 6. Central core 7 acts also as a spreader for the plastics flow passing through adapter and directs it towards the face of the

article. After the mould is opened over planes AA and BB, the article remains in plate 4 wherefrom it can be easily ejected by a textolite or aluminium rod.

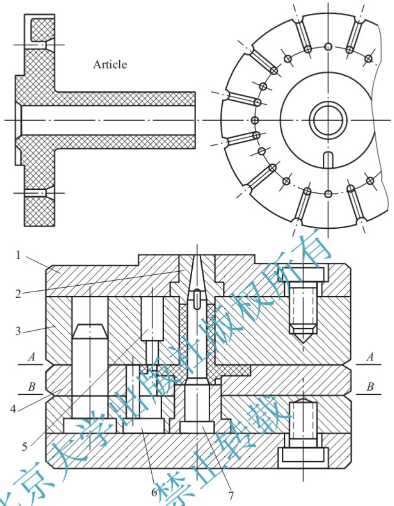


Fig. 19. 3　Loose Transfer Mould

1—top plate; 2—adapter(sprue bush); 3, 4—working plates; 5, 6—cores; 7—central core

Fig. 19. 4 shows a *fixed compression mould* for making a safety hood from thermosetting material. The mould is of one-impression design with one horizontal parting plane AA. The punch which shapes the internal cavity of the article is secured in punch holder 2. Arranged at the top is plate 1 for heating the punch with four holes receiving the electric heaters. The corners of punch holder 2 are provided with slots (not shown in the figure) for bolts securing the top of the mould to the press platen. The bottom of the mould comprises die 3 mounted on heating plate 6, support posts 8, clamping plate 12 securing the mould to the press bed, and the mechanism for ejecting the moulded article. The latter comprises ejectors 5 driven by the press lower ram connected to them by means of shank 11. To preclude misalignment in motion, plates 9 and 10 of the ejection mechanism with ejectors 5 and shank 11 are guided over posts 13. The separate components of the mould bottom are fastened together by bolts 7. To reduce the heat loss, the outside of the die is enclosed in asbestos casing14.

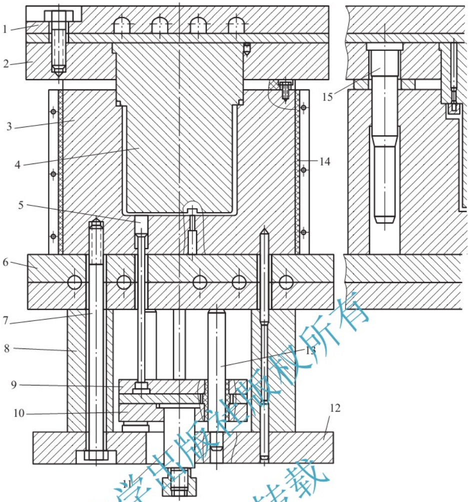


Fig. 19.4 Fixed Compression Mould

1—punch heating plate; 2—punch holder; 3—die; 4—punch; 5—ejector; 6—die heating plate; 7—bolt; 8—support post; 9, 10—ejection plates; 11—shank; 12—clamping plate; 13—guide post; 14—casing; 15—post

The working principle of the mould is as follows. Prior to moulding, the material is loaded into die 3 of the mould. Then the working ram of the press is engaged and the moulding is performed by descending it. During the operation the punch is kept in correct position with respect to the die by posts 15. By the end of the stroke of the top ram the mould is completely clamped, and the moulding material fills in the space between the punch and the die and is formed into the article. After the curing necessary for a complete setting up of the article, the top ram of the press is engaged for ascending and the mould is unclamped. Next, to remove the moulded article from the die, the bottom ejection ram is engaged; it actuates upon shank11 to lift plates 9 and 10. Ejectors 5 secured in the plates remove the ready article from the die.

参考译文:

Reading 19　压 模 模 具

让我们思考几种典型的加工热固性材料的模具设计。

那些专门制作热固性材料产品的生产商广泛应用压缩模，因为它们效率最高。压缩模可用于制作不同尺寸和形状的产品。尽管如此，它们并不适合于生产带有薄金属加强筋、小直径深孔或者孔垂直于压模方向的产品。

图 19.2 显示的是带水平分型面 BB 的单型腔动模模具，用于变压室侧压缩模。带凸模 5 的上模闭合，通过导柱 9 与下模锁定。冲模 4 的顶端作为加料腔，为了简化制造工艺，采用了组合设计。制件底部由被称为镶块的部件 3 塑形，镶块 3 牢牢地安装在冲模 4 的开口内，并由支撑板 1 闭合。同样，凸模 5 固定在固定板 6(凸模固定板)上。模具的塑孔部件 2 和 8 称为型芯。

在成形操作结束后，模具从冲压机上拆卸下来，放在一种特殊装置上，以便从中取出成形的制件。脱模机 10 的脱料杆穿过支撑板 1 的脱模孔移动顶杆 7，从而脱出制件。

图 19.3 显示的是带有两个分型面 AA 和 BB 的单型腔动传递模。加料腔安装在顶板 1 上。塑性材料穿过接头 2(主流道衬套)注入型腔内。产品的外形在模板 3 和 4 中成形，而孔在型芯 5 和 6 的帮助下制作完成。还有中央型芯 7 也作为塑料流体的分离器，使流体穿越接头，引导其流向制件表面。当模具在分型面 AA 和 BB 处开启后，模板 4 中的制件可以容易地通过层夹布胶木杆或铝杆推出。

图 19.4 显示的是用热固性材料制作安全罩的一个定压缩模。模具是带水平分型面 AA 的单型腔设计。使制件内腔成形的凸模安装在凸模固定板 2 上。位于上部的用于加热凸模的模板 1，带有可接收电热器系统的四个孔。凸模固定板 2 带有螺栓插槽(图中未显示)的拐角。将模具上部固定在压力机压板上。模具底部包括安装在加热板 6 上的冲模 3、支柱 8 和将模具固定在压力机座上的锁紧模板 12 以及推出成形制件的机构。该机构构成的脱模机 5 由通过模柄 11 连接的压力机下锤头驱动。为了在运行时避免误差，带有脱模机 5 和模柄 11 的脱模机构的模板 9 和 10 由模柱 13 进行导向。模具底部的单独零件用螺栓 7 紧固在一起。为了减少热量流失，凹模外部被封闭在石棉套 14 内。

模具的工作原理如下：在成形之前，材料被装入模具的冲模 3 里，然后，通过下降冲压机的运行压头，塑形开始进行操作。在运行期间，凸模通过导柱相对于凹模 15 保持在适当的位置。待上压头行程结束时，模具完全锁紧，塑性材料填满了凸模和凹模之间的整个空间，使零件成形。在完成制件所必需的固化之后，冲压机上冲头开始上升，模具松开。接下来，为从模具中脱出成形的零件，底部的脱模活塞开始运动，它促使模柄 11 抬起模板 9 和 10，固定在模板上的脱模机 5 将加工好的零件从模具中脱出。

Unit 20

Text 20: The Automobile

Frame

The frame is the basic foundation of the automobile, a platform to which the rest of the automobile components are attached. Each **frame member**, or separate part of the frame, is constructed of heavy steel bars welded into a square or box shape. These tough frame members (see Fig. 20. 1), well-suited to supporting the car's tremendous weight, are fastened together in different framework designs[1].

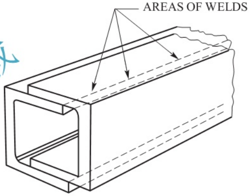


Fig. 20. 1 Cross Section of a Frame Member

One popular frame design uses two large side rails running beneath the sides of the car and a number of cross pieces, called cross members. This design (Fig. 20. 2) is often called a ladder frame because it resembles a stepladder. The ladder frame has one serious disadvantage. During a collision, the impact on one or another corner of the frame could push the frame out of square, resulting in the need for an expensive frame straightening[2].

In attempting to strengthen the ladder frame, car designers came up with the X-member frame (Fig. 20. 3). The X-member frame uses two large members that cross under the center of the car. These members are welded to the frame's side rails and cross members.

Some automobiles are constructed without a regular frame. In these vehicles a very thick sheet of metal, called the **floor pan**, is used to support the car. The body of the car is welded directly to the floor pan. The other components are attached to the body-floor pan assembly. This design, a **unitized body** or **monocoque design** (Fig. 20. 4), lends some advantages in terms of weight savings, and lower floor and production costs.

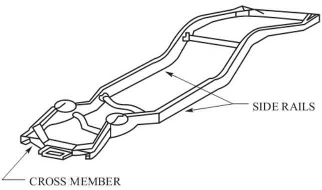


Fig. 20. 2　Typical Ladder Frame

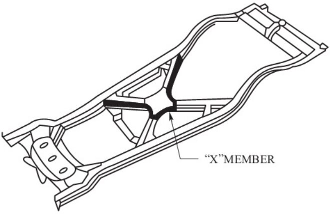


Fig. 20. 3　Typical X-member Frame

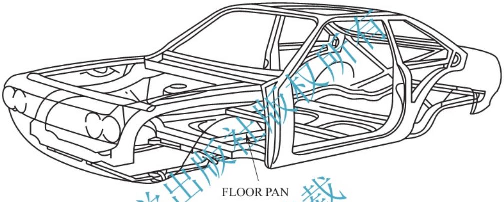


Fig. 20. 4　Unitized Body

The relative merits of frame construction versus the unitized body, in terms of ability to withstand a crash, have not been fully determined. There is a growing conviction, however, that the sheet metal in the unitized construction may absorb the energy of impact more effectively than the rigid members of a frame.

Unitized construction suffers from one clear disadvantage: road noise. When a car has a frame, the passenger compartment can be insulated from road noise by the insertion of rubber biscuits between the frame and body. With unitized construction, the noise telegraphs from the road directly into the passenger compartment.

Body

The bodies on the first automobiles were little more than platforms with seats attached. Increased use of cars meant growing concern for passenger comfort, however, and a closed compartment complete with roof and windows was finally developed. Since body shape is the main thing people notice about a car, body styling has always played an important role in sales.

Today, body design is influenced not only by a desire to protect people from the elements and offer an esthetically pleasing vehicle, but also by the need to protect passengers in a crash. Crash testing now plays a major role in body design[3].

The modern automobile body is constructed from sheets of steel formed to the required shape in giant punch presses. Most of the body components are welded together to form a

tight, rattle-free unit.

Although bodies are manufactured in an almost infinite variety, it is possible to categorize all body styles by size and type. The five body sizes are minicompact, subcompact, compact, midsize, and large. All of these sizes can apply to the eight body types, shown in Fig. 20. 5——two-door sedan, four-door sedan, convertible, hardtop, hatchback, station wagon, pickup truck, and van.

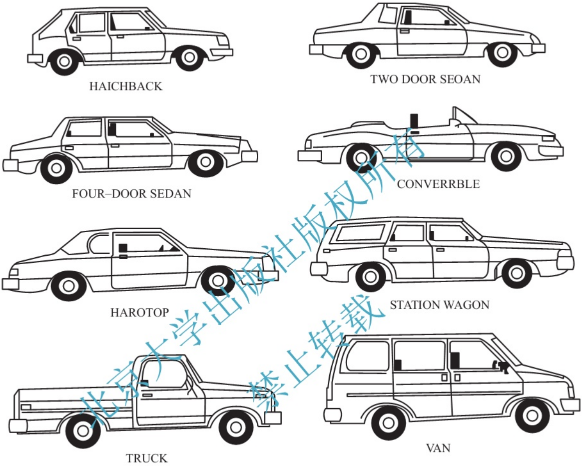


Fig. 20. 5 Automobile Body Styles

Engine

The engine (Fig. 20. 6), sometimes called the powerplant, makes the car go by using the explosive power of a mixture of gasoline and air or diesel fuel and air to push the **pistons**. The pistons are connected to a **crankshaft** and force it to turn. The rotating force of the crankshaft is used to make the car's wheels turn. In developing this power, the engine utilizes six different systems, described below.

(1) The **fuel system** provides the engine with a mixture of fuel and air in the correct quantities.

(2) The **ignition system** is designed to ignite the air-fuel mixture in the engine at the correct time.

(3) The **lubrication system** circulates oil throughout the engine to prevent wear.

(4) The **cooling system** removes destructive heat from the engine components.

(5) The **electrical system** provides electrical energy for starting, charging, ignition,

lights, and accessories.

(6) The **emission control system or systems** reduces or prevents the escape of pollutants into the atmosphere.

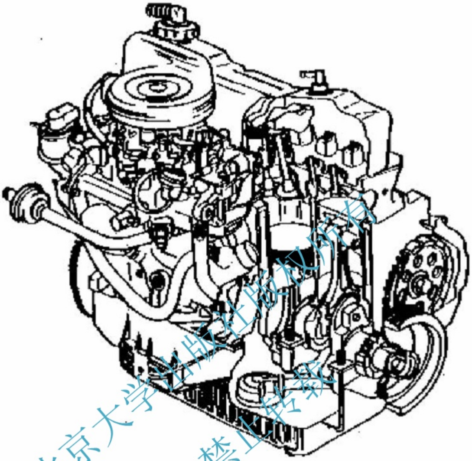


Fig. 20.6 Automobile Engine (Ford Motor Company)

The engine is mounted on the frame or underbody of the automobile. The most common American practice is to install the engine in the front of the car, because **a front-mounted engine** is readily accessible and can be cooled easily. European designers have often used **rear-engine placement**, which means the front of the car can be made more streamlined for better fuel economy. Also, the hood can be lower, driver visibility can be increased, and the engine's weight over the rear wheels can serve to increase traction in a rear-drive car.

Although front-or rear-engine placement is most common, the engine can also be placed in the middle of the car. The earliest cars, in fact, used **mid-engine placement**. When something went wrong with the engine, the driver had to get out and lift up the seat to work on it.

Mid-engine installation is now enjoying a resurgence in some American cars. A mid-engine car handles very well because the heavy engine in the middle of the car provides the best possible weight distribution[4]. Like the early vehicles, however, today's mid-engine car still suffers from inaccessibility. And instead of having the engine under the seat, a modern mid-engine sportscar has the engine behind the driver, which eliminates the rear seat.

Words and Expressions

1. automobile	['ɔːtəməubiːl]	*n.*	汽车(=motor car)
2. frame member			车架构件
3. steel bar			钢筋，钢条
4. tough	[tʌf]	*a.*	强硬的，坚韧的
5. well-suited	['wel'sjuːtid]	*a.*	适当的，便利的
6. side rails			纵梁
7. cross members			横梁
8. x-member frame			交叉型构件车架
9. come up with			①提出 ②想出
10. floor pan			(车身)浅盘形底板
11. weld	[weld]	*v.*	焊接，使结合
12. assembly	[ə'sembli]	*n.*	①装配，组装 ②集合，集会
13. unitized body			组合式车身，承载式车身
14. monocoque			硬壳式构造
15. relative merits			优缺点
16. withstand	[wið'stænd]	*v.*	①抵抗，经得起 ②对抗
17. conviction	[kən'vikʃən]	*n.*	信服，深信，坚信
18. rigid member			刚性构件
19. passenger compartment			乘客舱
20. insulate	['insjuleit]	*v.*	隔离，使绝缘
21. rubber biscuit			生胶块
22. little more than			只不过，仅仅是
23. elements	['elimənts]	*n.*	恶劣天气
24. punch press			冲压机，冲床
25. piston	['pistən]		活塞
26. crankshaft			曲轴
27. rotating force			旋转力
28. ignition system			点火系统
29. ignite	[ig'nait]	*v.*	点燃，使燃烧

30. lubrication system　　润滑系统
31. circulate　['səːkjuleit]　*v.* 循环，流通
32. accessory　[æk'sesəri]　*n.* 附件，辅助设备
33. emission control system　　排放控制系统
34. front-mounted engine　　前置发动机
35. readily　['redili]　*ad.* ①容易地 ②很快地，立即地
36. rear-engine placement　　后置发动机布置
37. hood　[hud]　*n.* 引擎罩
38. traction　['trækʃən]　*n.* 牵引力
39. mid-engine placement　　中置发动机布置
40. resurgence　[ri'səːdʒəns]　*n.* 复苏，再现，再起
41. inaccessibility　['inæk,sesə'biliti]　*n.* 难获得，难接近，难达到

Notes

1. These tough frame members (see Fig. 20.1), well-suited to supporting the car's tremendous weight, are fastened together in different framework designs.

本句中，主句为：These tough frame members are fastened together in different framework designs. 其中，由 well-suited 构成的短语结构作插入语，修饰本句的主语 members。因此，本句可译为：这些强韧的车架构件(见图 20.1)，是按照不同的车架设计固定在一起，有利于支撑汽车的巨大重量。

2. During a collision, the impact on one or another corner of the frame could push the frame out of square, resulting in the need for an expensive frame straightening.

本句中，主句为：the impact could push the frame out of square. 其中，resulting in…straightening 作伴随状语，表示结果。本句可译为：在汽车碰撞期间，对车架一角或另一角的撞击会使得车架变形，导致需要进行昂贵的车架矫直。

3. Today, body design is influenced not only by a desire to protect people from the elements and offer an esthetically pleasing vehicle, but also by the need to protect passengers in a crash. Crash testing now plays a major role in body design.

本句中，有一个固定搭配：not only…but also…，不仅…而且…。了解了此结构，便不难翻译。因此，本句可译为：如今，车身设计不仅受到人们希望汽车既能遮蔽恶劣天气又具美感和愉悦感的愿望的影响，而且还受到在撞车时保护乘客安全的需要的影响。目前碰撞试验在车身设计中起着重要作用。

4. A mid-engine car handles very well because the heavy engine in the middle of the car provides the best possible weight distribution.

本句是一个由 because 引导的原因状语从句。可译为：由于位于汽车中间的重型发动机提供了最佳可能的重量分布，所以中置发动机汽车的操纵性非常好。

Word - Study

Ⅰ. *Oppose*; *Defy*; *Withstand*; *Resist*

这些动词均含有“反抗，抵抗”之意。

oppose：普通用词，可表不同程度的抵抗。

defy：指公开地、勇敢地反对或抵抗，有时含公然挑衅之意。

withstand：较正式用词，指坚强地抵抗攻击或压力，有时也指抗住影响或吸引力。

resist：指积极地反抗一种攻击或暴力，或诱惑。

Ⅱ. *Result in*; *Lead to*

result in=to make something happen; lead to=to have something as a result

In most cases, both are interchangeable.

1. Forgetting to end a line in a semicolon will *result in/lead to* a compiler error.
2. Do so may *result in/lead to* serious damage to the components.
3. In chaos theory, the smallest initial perturbation can *result in/lead to* a huge change downstream.

Sentence Patterns

Ⅰ. Instead of, In place of + n./nominal phrase

Note: *instead of* really means to prep as an alternative of replacement to (sb./sth.), but it is often used in the same sense as *in place of*. Both are often used before noun or nominal phrase.

1. High-speed Hard Metal Milling / 2. Industrialization makes quantity + instead of / in place of + EDM. / quality.

3. In warm weather he often reads under a tree / 4. C Use Compressed size + instead of / in place of + in the library. / apparent size.

Ⅱ. Here are some useful patterns for expressing ‘reason’

1. 主句+because+原因状语从句
2. Since+原因状语从句+主句
3. As+原因状语从句+主句
4. 第一并列分句(表示结果)，for+第二并列分句(表示原因)
5. Not that…, but that…
6. 主语+谓语+(原因状语)

$\left\{\begin{array}{l}\text{thanks}\\ \text{due}\\ \text{owing}\end{array}\right\}$ to+名词

【句型 1】 主句+because+原因状语从句

说明：此句型中，because 是个连词，它用来表示直接的原因，一般来说原因状语从句放在主句之后，有时为起强调作用原因状语从句可以置于主句之前。

(1) You should not despise a man because he is poor.

(2) I am strict with you because I want you to make rapid progress. (如果要强调原因，原因状语从句可置于主句之前。如：Because I want you to make rapid progress, I am strict with you.)

(3) I went to bed early because I was tired. (如果要强调原因，原因状语从句可置于主句之前。如：Because I was tired, I went to bed early.)

【句型 2】 Since+原因状语从句+主句

说明：since 表示"原因"与 as 差不多，它所强调的是主句的内容，其原因是附带说明的。但 since 不同于 as 的地方，在于它所表示的原因是暗示出来的或稍加分析出来的。since 与 because 相比，since 的意味稍弱于 because。

(1) Since we're young, we shouldn't be too afraid of making mistakes.

(2) We had to put the meeting off since so many students were absent.

(3) Since we live near the forest, we enjoy a health climate.

【句型 3】 As+原因状语从句+主句

说明：as 从句所说明的原因是比较明显的，已被大家所熟知的。as 引导的原因状语从句在语气上比 because 引导的从句弱一些，as 从句虽然常出现在主句前面，但它证明的理由是附带的，而不是特别强调的。

(1) As I had a cold, I was absent from school.

(2) As he is a qualified doctor, I trust his advice on medical matters.

(3) As rain has fallen, the air is cooler.

【句型 4】 第一并列分句(表示结果), for+第二并列分句(表示原因)

说明：for 作连词时常用于书面语，比 because 更为正式，一般用逗号或分号和前面部分分开，它所引出的句子对前面的句子起解释作用。作为连词的 for，既然是用以说明或解释前句的，它就必须出现在前句之后和后句之首，这就是它与若干同义词的差别，试比较：He did not come for/as he was ill. 这句原文可改为：As he was ill, he did not come. 但不可改为：For he was ill, he did not come.

(1) It must have rained in the night, for when I woke the next morning I saw the grass wet.

(2) He felt no fear, for he was very brave.

(3) He couldn't go, for he was ill.

【注意】 在以下两种情况下一定要用 because，不能用 as 或 for。

1. 原因状语从句结合在"It is…that"强调句型当中，一定要用 because。

e. g. It is because he has behaved so badly that he must be punished.

2. 在回答 Why 问句时，也只能用 because。

e. g. Why was he late? Because he got up late.

【句型 5】 Not that…, but that…

说明：本句型指的是肯定一个原因，否定另一个原因，两个原因或理由一正一反前后对比。

(1) Not that it matters, but that how did you spend the money I gave you?

(2) Not that I don't like to play basketball, but that I like to play football.

(3) Not that she forgot to do her homework, but that she was busy nursing a sick classmate.

【句型 6】 主语＋谓语＋(原因状语)

说明：这三个短语都表示“由于”“因为”，thanks to 系由 thank 派生而来的，所以又含有“幸亏”的意思，due to 中的 due 原意是“应得的”，在这里用于连接因果关系，多指一种必然的现象。owing to 也有“幸亏”，“由于”的意思，三个词语可以作定语和表语。

(1) I was late thanks to the traffic.

(注：这里的 thanks to 表示的是“由于”，“因为”的意思。)

(2) It was thanks to his advice that I succeeded.

(注：这里的 thanks to 表示的是“幸亏”的意思。)

(3) The accident is due to your careless driving.

(4) It was owing to this difficulty that the plan did not succeed.

Exercises

Ⅰ. Give brief answers to the following questions.

1. What is called a ladder-frame?
2. What's the usage of the x-member frame?
3. What's the disadvantage of unitized construction?
4. Nowadays, why crash testing plays an important role in body design?
5. How many body sizes are there? What are they?
6. In developing the power, which systems do the engine utilize? How about their usages?

Ⅱ. Match the items listed in the following two columns.

Column A	**Column B**
1. ( ) side rails	A) 润滑系统
2. ( ) punch press	B) 交叉型构件车架
3. ( ) floor-pan	C) 横梁
4. ( ) cross members	D) 刚性构件
5. ( ) lubrication system	E) 曲轴
6. ( ) x-member frame	F) 钢筋，钢条
7. ( ) crankshaft	G) (车身)浅盘形底板
8. ( ) steel bar	H) 纵梁
9. ( ) rigid member	I) 冲压机，冲床

Ⅲ. Translate the following sentences into English.

1. 咱们玩纸牌吧，别看电视了。
2. 我特别地以红糖代替白糖做了这个蛋糕。
3. 我们有时候吃大米，不吃土豆。
4. 经济正在萎缩而不是在增长中。
5. 搬进来的不是格雷厄姆，而是彼得。

Ⅳ. Fill in the blanks with the prepositions given below.

in	of	into	to

1. An automobile has about 7000 parts ________ it.
2. The engine converts the fuel energy ________ mechanical power.
3. The hood and mudguards also belong ________ the body.
4. The basic components ________ the automobile are the engine, chassis and body.

Ⅴ. Fill in the blanks according to the text. Change the form where necessary.

a front-mounted engine	streamlined	rear-engine placement
install	mount	traction	visible

The engine is ________ on the frame or underbody of the automobile. The most common American practice is to ________ the engine in the front of the car, because ________ is readily accessible and can be cooled easily. European designers have often used ________, which means the front of the car can be made more ________ for better fuel economy. Also, the hood can be lower, driver ________ can be increased, and the engine' s weight over the rear wheels can serve to increase ________ in a rear-drive car.

Reading 20: Drivetrain

The power developed by the engine must be transferred to the drive wheels. This is the job of a number of components grouped together and called the drivetrain (Fig. 20. 7). The main component of the drivetrain is the **transmission**, which contains a system of gears used to multiply the engine's turning effort to get the car going forward or, when necessary, backward. A **drive shaft** is used to transfer power from the transmission to the **drive axle assembly**. The drive axle assembly contains another system of gears that transfers the engine's power to each of the drive wheels.

The typical drivetrain arrangement with a front-mounted engine is rear-wheel drive. This means the engine's power is sent to the rear wheels, which *push* the car along.

An alternative drivetrain arrangement with a front-mounted engine, however, is **front-wheel drive**: power goes to the front wheels, which *pull* the car. With this arrangement, the transmission and drive axle assembly are all combined in a single unit called the transaxle and mounted in the front of the vehicle.

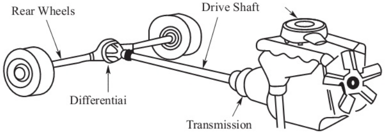


Fig. 20. 7 Drivetrain

Front-wheel drive has some advantages. The car may hold the road better on curves. There is no hump in the passenger compartment caused by routing the drive shaft under the vehicle. The vehicle has less weight because there is no long drive shaft and separate rear differential housing. Lower weight results in higher fuel economy.

There are two basic arrangements of front-wheel drive. The lengthwise mounting has the engine mounted in the standard front-to-back position as shown in Fig. 20. 8. The engine may be mounted ahead, behind, or on top of the driveline components.

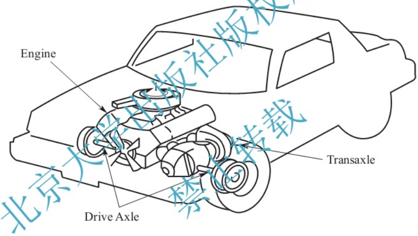


Fig. 20. 8 Front-wheel Drive Car with In-line engine

In the **transverse** configuration, the engine is mounted sideways, perpendicular to the length of the car. The transverse layout is popular because it requires the least amount of engine compartment space and allows more space for the passengers. A transverse engine layout is shown in Fig. 20. 9.

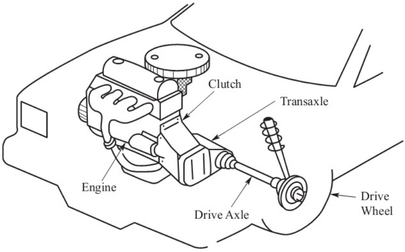


Fig. 20. 9 Front-wheel Drive Car with Transverse Engine

When the engine is placed in the rear of the car, the transmission and drive axle assembly are usually also in the rear. This eliminates the long drive shaft.

Another type of drivetrain arrangement is **four-wheel drive**, with the engine's power directed to driving axles located at both the front and rear of the vehicle (Fig. 20. 10). When four-wheel drive is engaged, all of the wheels are driven by the engine, and maximum traction can be achieved. The vehicle is able to climb steep hills and drive through deep sand or snow. The extra components required for four-wheel drive make it an expensive addition, mostly appropriate for off-the-road vehicles such as jeeps and trucks. But four-wheel drive is also used in some late model passenger cars.

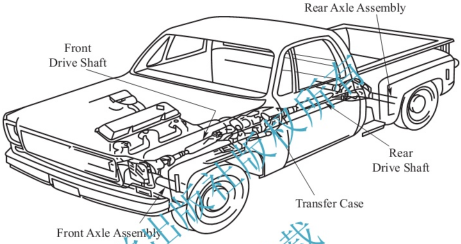


Fig. 20. 10 Four-wheel Drive Vehicle Transfer Case (General Motors Corporation)

Chassis

The term chassis describes all the parts of the automobile under the body. The major components of the basic chassis are the frame, engine, and drivetrain. In addition, several other systems are mounted to the chassis assembly. The wheels of the automobile are connected to the frame by a system of springs, shock absorbers, and linkages that make up the car's **suspension system** (Fig. 20. 11). The suspension system absorbs road shocks as the vehicle travels over rough roads and plays a major role in permitting easy handling of the vehicle during cornering.

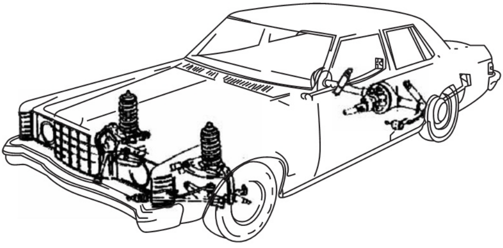


Fig. 20. 11 Suspension System

Another important chassis component is the **steering system** (Fig. 20. 12). The steering wheel, which the driver controls, is connected to a gearbox that multiplies the driver's effort. The gearbox is linked to the front wheels of the vehicle.

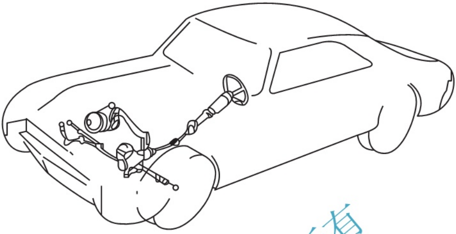


Fig. 20. 12 Steering System

The last major chassis component is the **braking system** (Fig. 20. 13). When the driver pushes on the brake pedal, hydraulic fluid is forced out of a master cylinder to each of the four wheels. The resulting *hydraulic pressure* operates a drum or disk brake assembly to slow or stop the car's wheels.

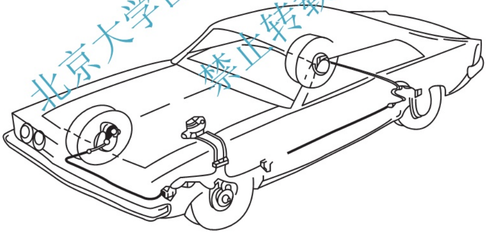


Fig. 20. 13 Braking System

参考译文：

Reading 20 驱 动 系 统

发动机所产生的动力必须传递到驱动轮，这是由许多零件组合在一起的机构的职能，零件的组合体被称为驱动系统(图 20. 7)。驱动系统的主要构件是变速箱，变速箱包含齿轮系统，齿轮系统用于放大发动机回转力，从而使汽车向前运行，或者必要时向后运行。传动轴将动力从变速箱转移到驱动桥总成。驱动桥总成包含另一齿轮系，该齿轮系将发动机

动力传递给每一个驱动轮。

典型的前置发动机驱动系统配置是后轮驱动。也就是说，发动机的动力被传递到后轮，由后轮推动汽车向前运动。

另一种前置发动机驱动系统配置是前轮驱动：动力传到前轮，拉动汽车。采用这一配置，变速箱和驱动桥总成连为一体，称为驱动桥，置于汽车前部。

前轮驱动有许多优势。汽车可以更加安全平稳地行驶于弯道。乘客舱内没有因布置车下驱动轴路线所引起的隆起。没有了长驱动轴和单独的后差速壳，汽车重量减轻。重量越轻，燃油经济性越好。

基本的前轮驱动配置有两种。纵向配置将发动机安装在水平贯穿前后的位置，如图 20.8 所示。发动机也可安装在前部、后部或动力传动部件的上面。

在横向配置中，发动机安装在侧面，垂直于车长。横置布局很普遍，因为它要求的动力舱空间最小，从而为乘客营造了更大的空间，横置发动机布局如图 20.9 所示。

当发动机置于汽车后部时，变速箱和驱动桥总成通常也在后部，这就取消了长传动轴。

驱动系统配置的另外一种类型是四轮驱动，即发动机动力直接传给位于汽车前轮和后轮的驱动桥上(图 20.10)。当四轮驱动工作时，发动机驱动所有车轮，达到牵引力最大。此类机动车可以爬陡坡，可以在深沙和深雪中穿行。四轮驱动所要求的额外零件很昂贵，主要适用于越野车，如吉普、卡车。但是一些最新型号的轿车也采用四轮驱动。

汽车底盘

汽车底盘指车身下面汽车的所有部件。基本底盘的主要构件是车架、发动机和驱动系统。此外，汽车底盘上还安装了几个其他系统。汽车车轮通过一个由弹簧、减振和连杆机构所组成的悬挂系统(图 20.11)连接在车架上。当汽车行至凹凸不平的路面时，悬挂系统会吸收不平路面带来的冲击和振动，并且在转弯时，对于汽车的易操纵性也起着十分重要的作用。

另外一个重要的底盘部件是转向系统(图 20.12)。驾驶员所操控的方向盘与放大驾驶员操作的齿轮箱相连，齿轮箱与汽车的前轮相连。

底盘最后一个主要部件是制动系统(图 20.13)。当驾驶员踩刹车踏板时，迫使液压油从主油缸喷出，流到每个车轮，所产生的液体压力控制鼓式制动器或盘式制动器，使车轮减速或停止运转。

参 考 答 案

Unit 1

Answers:

Ⅰ. 1. Up to the limit of about 1.5%.

2. It helps to relieve any internal stresses which exist in the metal.

3. We therefore heat it again to a temperature below the critical temperature, and cool it slowly. This treatment is called tempering.

4. We can obtain bars and sheets of steel by rolling the metal through huge rolls in a rolling-mill.

5. We can make steel harder by rapid cooling.

Ⅱ. 1. F 2. A 3. B 4. E 5. H 6. D 7. C

Ⅲ. 1. The carbon content of cast-steel is more than that of mild steel.

The carbon content of mild steel is not so much as that of cast-steel.

2. Wrought-iron contains as much carbon as manganese.

3. The French engine weighs more than British engine.

The British engine does not weigh so many as French engine.

4. The gas heater costs more an hour to run than the electric heater.

The electric heater does not cost so much to run as the gas heater.

5. Cast iron contains more percentage of silicon than that of phosphorus.

Cast iron does not contain so much phosphorus as silicon.

6. The temperature in this room is higher than the temperature outside the rood.

The temperature outside the rood is not so high as the temperature in this room.

Ⅳ. 1. makes 2. enables to 3. allows to 4. makes 5. makes 6. enables to 7. makes 8. allows to 9. allows to 10. enables to

Unit 2

Answers:

Ⅰ. 1. Soldering gives a satisfactory joint for light articles of steel.

2. Pressure welding.

3. The welding temperature should be about 1300℃.

4. For fairly thick bars of metal, a vee-shaped weld should normally be employed.

5. A different method is usually employed for welding sheets or plates of metal together. This is known as spot welding.

Ⅱ. 1. B 2. E 3. C 4. G 5. D 6. F 7. H 8. A

Ⅲ. 1. This type of metal can be cast into very complicated shapes by us.

2. The ore was smelt in a blast furnace and was reduced to pig iron.

3. Many operations can be carried out on a lathe by a skilled operator.

4. The two metal plates are clamped by us.

5. Millions of tons of coal are produced by coal miners every week.

6. Several new products are marked by the company every year.

7. Production on the new type of reactor will be started soon.

8. Heat for welding can be generated in several ways by us.

9. An electric current is passed across the electrodes by us.

10. A vee-shaped weld is normally preferred by welders.

Ⅳ. 1. should give 2. should be 3. should be permitted 4. should be tempered 5. should have been 6. should be applied 7. should have 8. should be written 9. should be reduced 10. should be allowed

Unit 3

Answers:

Ⅰ. 1. The rake angle is an angle between the upper surface of the tool and the plane perpendicular to the machined surface of the workpiece.

The tool angle is the angle confined between the face and the flank of the tool.

The lower surface of the tool (called the flank) makes an angle with newly machined surface of the workpiece, which is called the clearance angle.

2. The resistance to the flow of the removed chips depend mainly on the value of the rake angle.

3. The algebraic sum of the rake, tool, and clearance angles is always equal to 90°.

4. (1) Improved quality of the machined surface.

(2) A decrease in the energy consumed during the machining operation. That energy is mostly converted into heat.

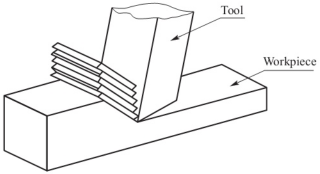
(3) Longer tool life as a result of a decrease in the rate of tool wear, since the elapsed heat would be reduced to minimum.

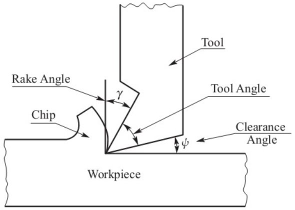
Ⅱ. 1－5 H E C F B 6－10 G J A D I

Ⅲ. 1. enable 2. entangled 3. enlarging 4. ensure

Ⅳ. 1. converted 2. perpendicular 3. ductile 4. brittle 5. As a consequence 6. required

V.





Ⅵ. 1. B 改为 that。
2. C ones 改为 one。
3. D those 改为 that。
4. C that of 改为 those of。

Unit 4

Answers:

Ⅰ. 1. The cylindrical surface is the major form.
2. The essential components of a lathe are the bed, headstock assembly, tailstock assembly, carriage assembly, and the leadscrew and feed rod.

Ⅱ. B D G F E C A

Ⅲ. 略

Ⅳ. 1. achieve 2. produces 3. production 4. achieved 5. reached 6. attain 7. specified

Unit 5

Answers:

Ⅰ. 1. Numerical control can be defined as a form of programmable automation in which the process is controlled by numbers, letters, and symbols.
2. The program consists of precise instructions about the manufacturing methodology and the movements.
3. The majority of applications of NC is in metal cutting machine tools such as milling machines, lathes, drilling machines, grinding machines and gear generating machines.

Ⅱ. B C E F G D A

Ⅲ. 略

Ⅳ. 1. capability 2. positioned 3. manufactures 4. flexibility 5. instructions;

Unit 6

Answers:

Ⅰ. 1. Static balance is a subset of dynamic balance.

2. Static balancing can be an acceptable substitute for dynamic balancing and is generally easier to do.

3. Because there exist the vagaries of production tolerances.

4. The amount and location of any imbalance can be compensated for by adding or removing material in the correct locations.

5. The requirement for static balance is simply that the sum of all forces on the moving system must be zero. As to dynamic balance, it requires that two criteria be met. The sum of the forces must be zero plus the sum of the moments must also be zero.

6. The common denominator among these devices is that they are all short in the axial direction compared to the radial direction, and thus can be considered to exist in a single plane.

7. The common denominator among these devices is that their mass may be unevenly distributed both rotationally around their axis and also longitudinally along their axis.

Ⅱ. 1. (F) Theoretically

2. (T)

3. (F) Static balance

4. (F) Auto tires are sometimes statically balanced. More often they are dynamically balanced.

5. (T)

Ⅲ. 1. D 2. F 3. G 4. H 5. B 6. A 7. E 8. C

Ⅳ. 1. balanced 2. balance 3. balance 4. imbalance 5. unbalanced

Ⅴ. 1. I suggested that he finish up that project quickly.

2. I demanded that he accompany me to the hearing.

3. She insists that he take his vacation now.

4. I prefer that Mary type the letters.

5. He advised that she wait for a few weeks.

6. He ordered that the troops march to the front at once.

Unit 7

Answers:

Ⅰ. 1. Spur Gears are ones in which the teeth are parallel to the axis of the gear.

2. They run quieter than spur gears because of the smoother and more gradual contact between their angled surfaces as the teeth come into mesh. Also, for the same gear diameter and diametral pitch, a helical gear is stronger due to the slightly thicker tooth form in a plane perpendicular to the axis of rotation.
3. The advantage compared to a helical gear is the internal cancellation of its axial thrust loads since each “hand” half of the herringbone gear has an oppositely directed thrust load.
4. The ratio of the gearset is equal to one over the number of teeth on the worm gear.
5. Bevel gears are based on rolling cones.

Ⅱ. 1. D 2. A 3. E 4. B 5. C

Ⅲ. 1. identical 2. compatible 3. cancellation 4. accommodate 5. perpendicular 6. meshed/mesh 7. No…other than 8. vibration 9. analogous 10. with respect to

Ⅳ. (a) spur gears; (b) worm and worm gear; (c) parallel axis helical gears; (d) crossed axis helical gears; (e) bevel gears; (f) herringbone gears.

Unit 8

Answers:

Ⅰ. 1. Bearings are things which support the shafts to keep them steady.
2. We can classify them according to whether they take the load on the shaft or the thrust along the axis of the shaft.
3. (1) We can avoid making the shaft and the bush of the same material.
(2) We can reduce the danger of overheating by lubrication.
4. Metals such as cast-iron or bronze or white metal are commonly used to make the bush.
5. At a certain temperature, the metal in the bush will seize or run, and this will prevent damage to the shaft.
6. (1) To reduce the danger of overheating.
(2) To prevent the metal surfaces from corroding.
7. An oily lubricant is better for high-speed bearings while lighter oil is better for low-speed bearings.
8. (1) Drip down under the influence of gravity. More commonly,
(2) Use a pump or gun to feed it in under pressure.
(3) Half cover the bearing in an oil-bath, and oil splashes up into it.

Ⅱ. 1. (T)
2. (F) (The shaft has to have a bush or tube.).
3. (F) (It can not prevent the overheating from occurring.)
4. (T)
5. (F) (under the influence of gravity)

Ⅲ. 1. stationary 2. slid 3. overheat 4. corrode 5. fed 6. lubricate

Ⅳ. 1. H 2. D 3. G 4. F 5. B 6. E 7. A 8. C

Unit 9

Answers:

Ⅰ. 1. CAD stands for computer-aided design and CAM stands for computer-aided manufacturing.

2. Increased productivity; better quality; better communication; common database with manufacturing; reduced prototype construction costs; faster response to customers.

3. It gives the designer more time to spend on conceptualizing and completing the design. In addition, the amount of time required to document a design can be reduced significantly with CAD/CAM.

4. CAD/CAM allows designers to focus more on actual design problem and allows designer examine a wider range of design alternatives. Fewer design errors occur.

5. With CAD/CAM, 3-D computer models can reduce and, in some cases, eliminate the need for building expensive prototypes. It allows designers to substitute computer models for prototypes in many cases.

Ⅱ. 1. productivity 2. productivity 3. unproductive 4. productive

Ⅲ. 1. focus 2. eliminate 3. manual 4. range 5. accurate

Ⅳ. 1. entail 2. set 3. productivity 4. automatic 5. enables 6. create 7. logical 8. stored 9. identification 10. illustrates

Unit 10

Answers:

Ⅰ. 1. Dies are classified according to their application, design features, methods of blank feeding, and scrap ejection.

2. The die design should suit the scale of production it will be used for: small-lot, large-lot, or mass production.

3. Dies should meet the following requirements:

(1) the accuracy and surface finish of stampings should conform to the drawings and specifications;

(2) the working parts of the die must be adequately strong, durable in operation, and easily replaceable when worn out;

(3) the die is to ensure the required hourly output, easy maintenance, safe operation, and reliable fastening in the press;

(4) the die should be designed preferably of standard components, using as few special parts as possible;

(5) the scrap in the stamping operation must be kept at a minimum.

4. Die components may be divided into 7 types:

(1) working components, which participate in the shaping of parts (punches, dies, and their sections);

(2) structural components, which serve for joining the pieces of a die to one another and to the press (upper and lower die shoes, shanks);

(3) guiding components, which ensure accurate alignment of the punch with the die shoe in operation (guide posts and bushings);

(4) feeding components, which feed the stock or blanks to the stamping station;

(5) locating and locking components, which provide for and accurate positioning of the stock or blank in the die and fix it in place while the operation is performed;

(6) stripping components, which are intended for stripping and removing the blanks and scrap after the operation is over (strippers, knockouts);

(7) fastening components, which join and hold together all parts and units of the die (punch holders, die blocks and cases, all fasteners).

5. (1) upper shoe; (2) shank; (3) guide-post bushing; (4) guide post; (5) lower shoe; (6) die; (7) punch; (8) positioners; (9) punch retainer; (10) stripper

Ⅱ. (略)

Ⅲ.

1. scrap ejection	废料排出
2. trimming	切边
3. positive knockout	直接落料
4. blank feeding	坯料进给
5. notching	开槽，开凹口
6. blank	坯料
7. blanking	落料
8. stock	原料

Ⅳ. 1. preferably 2. maintenance 3. automatic 4. applications 5. durable 6. by means of 7. compression 8. fall into 9. shaped 10. adequately

Unit 11

Answers:

Ⅰ. 1. Alloy steels may be defined as steels with alloying elements that exceed one or more of the following limits: 1.65Mn, 0.60Si; 0.60 Cu or aluminum, boron, chromium up to 3.99%; and containing one or more of the following elements: cobalt, co-

lumbium, molybdenum, nickel, titanium, tungsten, vanadium, and arconium.

2. The highest nominal carbon content is 0.95%.
3. Four. Machinability, Formability, Weldability, Castability.
4. Basically HSLA steels are low carbon steels and the maximum carbon content is 0.28%

Ⅱ. 1. G 2. F 3. A 4. E 5. B 6. H 7. D 8. C

Ⅲ. 1. A letter is written by Bruce every week.
2. The broken bike was mended by Li Lei this morning.
3. Two novels have been written by him so far.
4. Ten trees will be planted by them tomorrow.
5. A letter is being written by Lucy now.
6. The door must be locked when you leave.

Unit 12

Answers:

Ⅰ. 1. Type of welding process. Environment. Alloy composition. Joint design and size, all these factors can be decisive to the alloy's weldability.
2. Some people even argue that since virtually all metals and alloys can be welded, the term may even be redundant!
3. By far the most important technique used in welding construction today is fusion welding, which is the main process discussed herein.

Ⅱ. 1. electrode 电极
2. oxide 氧化物
3. moisture 水分，水气，湿气
4. droplet 小滴
5. viscosity 黏稠；黏性
6. solidify (使)成为固体
7. feed 加进(原料等)
8. thermal 热的，热量的，由热造成的

Ⅲ. (略)

Ⅳ. 1. contains 2. content 3. content 4. consists 5. composition includes 6. makes up 7. consists of 8. is made up of 9. constitute 10. consists of

Unit 13

Answers:

Ⅰ. 1. It is based on the design process.

2. It is impossible.
3. Unilateral tolerance and bilateral tolerance.
4. In unilateral tolerance，the variation of the size will wholly on one side.
5. In bilateral tolerance，the variation will be to both the sides.

Ⅱ.

dimension	尺寸
assembly	装配
deviation	尺寸偏差
shaft	轴
unilateral tolerance	单向公差
transition fit	过渡配合
bilateral tolerance	双向公差

Ⅲ. 略

Ⅳ. 1. basis　2. base，based　3. based　4. basic　5. base

Unit 14

Answers:

Ⅰ. 1. in which，2. on which，3. by which，4. for which，5. at which，6. by means of which.

Ⅱ. 1. Strength，elastic，and ductility properties for metals，plastics，and other types of materials are usually determined from a tensile test in which a sample of the material，typically in the form of a round or flat bar，is clamped between jaws and pulled slowly until it breaks in tension.

2. Because the stress in the bar is equal to the applied force divided by the area，stress is proportional to the applied force.
3. The peak of the stress-strain curve is considered the ultimate tensile strength (S_u)，sometimes called the ultimate strength or simply the tensile strength.
4. That portion of the stress-strain diagram where there is a large increase in strain with little or no increase in stress is called the yield strength.
5. If the point of yielding is quite noticeable，the property is called the yield point rather than the yield strength.
6. A line is drawn parallel to the straight-line portion of the curve and is offset to the right by a set amount，usually 0.20% strain (0.002 mm/mm). The intersection of this line and the stress-strain curve defines the material's yield strength.

7. Because the proportional limit and the elastic limit are difficult to determine.

8. The modulus of elasticity indicates the stiffness of the material, or its resistance to deformation.

Ⅲ. 1. (F) (not quickly but slowly) 2. (F) (not occasionally but continuously) 3. (T) 4. (F) (not commonly but rarely) 5. (T)

Ⅳ. 1. monitor 2. proportional 3. yield 4. pronounced 5. intersection 6. offset 7. slope 8. tension

Ⅴ. 1. F 2. G 3. E 4. H 5. A 6. D 7. B 8. C

Ⅵ. 1. peculiarities 2. properties 3. characters 4. characteristic 5. traits 6. feature 7. attribute

Unit 15

Answers:

Ⅰ. 1. Select the material from which the shaft will be made, and specify its condition cold-drawn, heat-treated, and so on. Plain carbon or alloy steels with medium carbon content are typical, such as AISI 1040, 4340, 4640, 5150, 615 and 8650. Good ductility with percent elongation above 12% is recommended.

2. In general, the critical points are several and include those where a change of diameter take place, where the higher values of torque and bending moment occur, and where stress concentrations.

Ⅱ. 1. D 2. C 3. H 4. B 5. E 6. A 7. G 8. F

Ⅲ. 1. typically 2. restrain 3. transmitting 4. diameter 5. perform 6. Gears 7. torque 8. carbon 9. intermediate 10. mounting

Ⅳ. 1. mounted 2. transmit 3. forces 4. overloading 5. deflection 6. combination 7. equivalent 8. torsion 9. bending 10. fatigue

Unit 16

Answers:

Ⅰ. 1. Squirt Shape is a fully-automated system for the production system for the production of sockets using computer-based shape information.

2. Our approach will capitalize on the features of Squirt Shape to enable us to reduce or eliminate the need for fasteners such as screws, nuts and washers. Furthermore, we anticipate a reduction in the number of components needed to produce a limb, and consequently a reduction in the weight of the limb.

Ⅱ. E), C), A), H), F), B), G), D)

Ⅲ. 1. integration 2. resultant 3. depends on 4. In addition to 5. conventional 6. deposit

Ⅳ. 1. 钴基焊丝是用于起重机械的原材料。
2. 它们对钢材成本的影响可能远远超过长协矿价格的影响。
3. 通过一个研究实例描述共链分析的主要应用方式和效果。
4. 合作可以让我们学会团结，在合作中我们也可以感受到许多快乐和幸福。

Unit 17

Answers:

Ⅰ. 1. The characteristics of the individual components used and their interaction determine the performance characteristics of the circuit.
2. Four.
3. The basic areas of control are flow control, pressure control, direction control.

Ⅱ.

performance	性能
valve	阀
potential	位势，液压
open-loop circuit	开环回路
sequence	顺序，序列
reversible	双的
interaction	相互作用

Ⅲ.（略）

Ⅳ. 1. performed 2. source 3. potential 4. performance 5. involved

Unit 18

Answers:

Ⅰ. 1. In the early days of robots, the Japanese defined an industrial robot as an all purpose machine, equipped with a memory and an appropriate mechanism to perform motions automatically, thus replacing human labor.
2. Six. Manual manipulator. Fixed-sequence robot. Variable-sequence robot. Playback robot. NC robot. Intelligent robot.
3. Another narrower definition is given by RI (Robot Institute of America, Dear-

born, Michigan), which defines a robot as "A reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks."

Ⅱ. 1. A. 2. C 3. C 4. worriedly 改为 worried. 5. fewer 前加 the .

Ⅲ. 1. basics 2. grounds 3. base 4. foundation 5. grounds 6. basis

Unit 19

Answers:

Ⅰ. 1. The moulds are classified into compression and transfer ones.

2. The part of the mould which accommodates the loading chamber and the bottom shaping cavity is called a die.

3. There are two basic types of transfer moulds:

(a) with a loading chamber (for use in presses)

(b) without a loading chamber (for use on injection machines).

4. The loose moulds are of low efficiency, they are applicable when making small lots of products.

5. A parting plane of the mould is a term applied to the surface over which the moulding parts open.

Ⅱ. 1. D 2. E 3. A 4. F 5. B 6. C

Ⅲ. 1. Clamp 2. exert 3. intricate 4. transfer 5. consists in 6. are classified into

Ⅳ. transfer; thermoplastic compounds; injection; cavity; sprue channels; heating cylinder

Unit 20

Answers:

Ⅰ. 1. One popular frame design uses two large side rails running beneath the sides of the car and a number of cross pieces, called cross members. This design (Fig. 1. 3) is often called a ladder frame because it resembles a stepladder.

2. In attempting to strengthen the ladder frame, car designers came up with the x-member frame . The x-member frame uses two large members that cross under the center of the car. These members are welded to the frame' s side rails and cross members.

3. road noise. When a car has a frame, the passenger compartment can be insulated from road noise by the insertion of rubber biscuits between the frame and body. With unitized construction, the noise telegraphs from the road directly

into the passenger compartment.

4. Today, body design is influenced not only by a desire to protect people from the elements and offer an esthetically pleasing vehicle, but also by the need to protect passengers in a crash. Crash testing now plays a major role in body design.
5. Five. They are minicompact, subcompact, compact, midsize, and large.
6. The fuel system provides the engine with a mixture of fuel and air in the correct quantities.

The ignition system is designed to ignite the air-fuel mixture in the engine at the correct time.

The lubrication system circulates oil throughout the engine to prevent wear.

The cooling system removes destructive heat from the engine components.

The electrical system provides electrical energy for starting, charging, ignition, lights, and accessories.

The emission control system or systems reduces or prevents the escape of pollutants into the atmosphere.

Ⅱ. 1. H 2. I 3. G 4. C 5. A 6. B 7. E 8. F 9. D

Ⅲ. 1. Let's play cards instead of watching television.
2. I made this cake specially, with brown sugar instead of white.
3. We sometimes eat rice instead of potatoes.
4. The economy is shrinking instead of growing.
5. Instead of Graham, it was Peter who moved in.

Ⅱ. 1. in 2. into 3. to 4. of

Ⅴ. mounted; install; a front-mounted engine; rear-engine placement; streamlined; visibility; traction.